Editorial

Interest on Your Dues

THAT "one receives in proportion to what one gives" is a fine old saying. Regrettably, there are millions of people who have lost their perspective on that relationship. The philosophy of "hand outs" has reached astounding proportions, as we all know.

Realistically, a society has members only because it has something to give. Yet, a society, being a voluntary group of individuals with common interests, can contribute to its members only as the members themselves give to the organization.

Members give to The Electrochemical Society in many ways. Some give their time, that elusive thing "spare time" during which they function as elected officers or committee appointees, when they might be on that fishing trip, indulging in a hobby, or just taking it easy. Some make valuable contributions in the form of technical papers on subjects of interest to the other members. All members pay dues. Dues comprise the major contribution of a majority of the members.

By now, you are asking, "So what? Any member knows these things. All I want to know is 'What do I get for my money?' "

For $10.00 per year an active member gets the JOURNAL, the privilege of voting, and the opportunity to meet with others in his chosen field. How many members realize that The Electrochemical Society is one of the very few that has not raised its dues. Yet, steady improvement is being made in the services the members receive and in the quality of the JOURNAL. How is this possible?

There are many members (their employers too) who donate time to make

(*Continued on next page*)

Editorial (*continued*)

such an accomplishment possible. Their contributions are "the interest on the dues" that is received by the other members. Even so, making ends meet is a problem requiring closest watching by the officers, who, at the risk of being dubbed old-fashioned, believe in operating on a balanced budget and are striving to do so without increasing the dues. Real economies effected in publication have enabled the National Office to meet the needs of a growing Society. However, with universal rising costs, the coming year will be a critical one in properly balancing income and expenditures. Additional income is needed. Rather than increase the dues, the Board of Directors has authorized the acceptance of suitable advertising for the JOURNAL. The latest information on the tools, materials, methods, books, and so forth, of the science and profession of Electrochemistry is as important to progress as are the results of research and industry.

The healthy condition and the bright future of The Electrochemical Society is directly traced to the willingness of so many members to share the burden of management and publication.

Who says these things? Any member, and the list is long, who has spent many hours on Society business for the sheer pleasure of contribution to a community interest—an American tradition that is being lost in so many quarters today, but not, we are thankful, in The Electrochemical Society.

CHARLES L. FAUST

The Platinum Metals: A Review of Their Properties and Uses

*Edmund M. Wise**

Introduction

Platinum is a relative newcomer among the precious metals, having been known to the scientific world for only about 200 years, although used earlier than that by the natives in South America. In contrast, gold has been in use for at least 6,000 years, while silver came into use some time later. Gold and silver were first used for appearance applications. The industrial use of silver is relatively recent, and that of gold is still minor. In contrast, platinum and, later, the other metals of this sextet were first used principally for scientific and industrial purposes. Jewelry uses developed only within the present century, the use of platinum for jewelry becoming important about 1906 and palladium within the past ten years.

The chemical properties of the platinum group metals are such that many difficult problems are encountered in effecting clean-cut separations between these metals and also in eliminating impurities. Some of the salts exhibit unusual behaviors and, in some cases, their solutions yield practically zero concentrations of the platinum metal ion. At times this characteristic is useful, but at others it probably has resulted in running valuable solutions to waste because they were thought to be barren. Even after good separations were effected, the high melting temperature of platinum challenged metallurgists and chemists and led Knight, Wollaston, and others to develop the powder metallurgy process nearly 150 years ago. Wollaston described this process in considerable detail in 1829 (1).

Wollaston's comments regarding the proper kind of powder and the precautions in handling, to secure good results, are still valid. Various artful dodges for temporarily lowering the melting temperature of platinum by alloying ti with arsenic, etc., and subsequently removing the added element, also were tried, but the sintering method made these obsolete and was employed until it was largely supplanted by melting with an oxyhydrogen flame on a lime block. This occurred in 1856, and the use of this excellent refractory was due to Deville and Debray (2).

The oxyhydrogen torch was developed about 1802 by Robert Hare in Philadelphia, and, indeed, he used it some years later to melt the platinum on a charcoal block, but platinum melted under these circumstances would not be ductile. However, the sintering process did not completely vanish from the platinum art and in the last few years has come into use again in producing certain platinum alloys for spark plug electrodes and other applications where a very high recrystallizing temperature is required. As is well known, the sintering process later made possible the production of ductile tungsten and molybdenum, as well as various lower melting metals and heterogeneous mixtures including tungsten carbide.

It is evident that the special properties of platinum stimulated investigators and inventors and led to processes which became valuable in other fields as well. The direct use of platinum, and later of the other platinum metals, for chemical equipment such as evaporating pans, crucibles, resistance thermometers, thermocouples, electrical contacts, metal-to-glass seals, electrodes, and catalysts has been of paramount importance Oftentimes these metals offer an early and frequently a permanent solution to problems with which other materials cannot cope.

Applications in Catalysis

Currently, the most important application of the platinum metals in the chemical field is in the production of nitric acid by the catalytic oxidation of mixtures of ammonia and air by passing the mixture through a layer of 10 per cent rhodium, 90 per cent platinum alloy gauze (3). The conversion efficiency is extraordinarily high, of the order of 97 per cent, and the life of the gauze is very long. In the older plants, operating at atmospheric pressure, the production of 1,000,000 pounds of HNO_3 consumed only about one ounce of gauze. In the newer plants, operating at elevated pressures, the loss of catalyst is considerably higher, but other advantages of pressure operation more than counterbalance this. In addition to supplying practically all of the world's nitric acid, the platinum gauze catalyst converter can be made in small units suitable for supplying the nitrogen oxides to chamber process sulfuric acid plants. These small units have replaced most of the niter pots which were formerly used for supplying the nitrogen oxide catalyst.

Platinum is, of course, an excellent catalyst for the direct production of sulfuric acid, and substantial quantities are in use for this purpose, particularly for producing "fuming sulfuric acid," although a vanadium catalyst has found extensive use in this process, particularly for producing 98 per cent acid. The possibilities of converters utilizing vanadium for the high temperature portion of the cycle and platinum for the low temperature portion, where

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great activity is required, have been considered.

In the field of hydrogenation and dehydrogenation, both palladium and platinum are employed, and ruthenium has been explored for certain special hydrogenations. It is interesting to note that the use of the platinum metal for catalysis is not confined solely to the production of expensive organic chemicals, such as certain vitamin adjuncts and complex organics, but also is used for some very low cost products where the extreme activity of the catalysts permits operation at low temperatures and pressures, thus reducing the cost of operation over that possible with other catalysts. Under some circumstances, the relative insolubility of the platinum metals is of controlling importance, as contamination of the end product by dissolved catalyst would be highly objectionable. In general, the catalysts for these organic reactions are supported on either activated alumina or activated charcoal and the metals are largely recovered after use. Recovery in the case of material supported on charcoal is, of course, easier because the mass may be burned to eliminate the supporting material and most of the contaminants acquired during use.

In the purification of hydrogen, a special palladium catalyst is employed to effect the combination of any oxygen with the hydrogen, so that the resulting water can be removed in the final drying operation. By this means, really oxygen-free hydrogen can be provided with little trouble or expense. Palladium also can be used as a diffusion septum through which hydrogen diffuses rapidly and selectively. As an indication of the order of magnitude of this process, a rate of 250 cubic feet of hydrogen per day (N.T.P.) per square foot of palladium .0016 in. thick may be expected at 400°C with a differential hydrogen pressure of one atmosphere between the two surfaces of the septum (4). Such diffusion devices operated at about 400°C provide extremely pure hydrogen and can also be used as hydrogen valves, as the flow drops sharply with the temperature. For long life in this service, sulfur-free gas and steady operation are required.

Corrosion Resistance

The nearly complete immunity of platinum to corrosion by hot HCl (5) has led to industrial use of platinum equipment for high temperature pyrolysis. Tubes lined with .010 in. of platinum have been in operation for several years at about 700°C. Platinum-clad or platinum-lined equipment also is in use for high pressure autoclaves and various other equipment. Thin platinum sheet is employed for pressure-limiting frangible disks.

Insoluble Anodes

The use of platinum as an insoluble anode is important in the production of "persalts" which are used either directly or, in the case of persulfuric acid, as the source of hydrogen peroxide. Pure platinum is employed in the production of persulfuric acid either in the form of thin solid sheet or platinum-clad rods of copper or silver. Obviously, the coating must be continuous and preferably is not less than .005 in. thick. All rods are inspected by immersing them for 24 hours in nitric acid, which would penetrate any small openings that may exist and attack the core.

The production of persulfuric acid has long been established, but the production of perchlorates on a large scale has always entailed considerable hazard. Some of this may have been occasioned by the use of graphite anodes which are attacked and may produce materials which can cause trouble. These difficulties have been avoided by dividing the oxidation into two stages. Oxidation to chlorate is effected with carbon or graphite anodes, and the chlorate, after purification, is oxidized to perchlorate with platinum anodes.

Platinum anodes also have been used in the production of chlorine and additional possibilities exist for this metal in cells designed to utilize it most effectively, particularly where extremely pure caustic, free from carbon compounds, and chlorine are required.

Platinum-clad anodes also have been used in the electrodeposition of nickel and certain other base metals where close spacing between anode and cathode is desired or where plating on the inside of tubes and pipes is required. It would seem that auxiliary platinum-clad anodes also would be useful in plating very irregular objects such as certain types of automobile bumpers. In this case, the main anodes could be of the soluble type, and the insoluble anodes would be on a separate circuit to provide the desired current distribution on the cathode.

Uses in the Rayon Industry

Another major industry relying on platinum alloys for its most critical requirements is the viscose rayon industry. In this operation, the cellulose xanthate solution flows through platinum alloy spinnerets into the acid coagulating bath containing hydrogen sulfide and various other corrosives. Pure platinum was used in the early equipment and, subsequently, the 30 per cent platinum, 70 per cent gold alloy came into extensive use. This in turn has been replaced in many plants by the 10 per cent rhodium, 90 per cent platinum alloy. In this application an extremely high level of corrosion resistance is required but, in addition, the material must be amenable to the intricate mechanical processes required for the production of the spinneret itself as the latter may contain from 50 to 5,000 holes, accurate in diameter and shape. It is also essential that the alloy be resistant to acid cleaning baths. In addition, the material should be easily recovered and reworked in the event that the spinnerets are mechanically damaged. The platinum metals meet these requirements successfully and economically.

Ceramic and Glass Industry Applications

Ceramists and glass technologists, as well as geochemists, have long used platinum for handling high-temperature fusions of glass and glass-like substances, but, in recent years, this general application of platinum and certain platinum alloys has grown to a large industry. One early application was in the metering of glass in the feeding mechanism employed in the production of black glass electrical insulating buttons for incandescent lamp bases. This metering mechanism relies upon the maintenance of a specific diameter of glass stream determined by an orifice. Orifices made of even the most refractory aluminous materials dissolved in the glass and caused difficulty, but the use of a 10 per cent rhodium-platinum liner completely avoided this trouble (7).

Many other applications in the glass industry have since developed, utilizing platinum elements for regulating the flow of glass and also for melting glass and allied materials without contamination. This includes the production of various optical glasses and also single crystals of various inorganic salts by the progressive solidification of very high purity salt held in a large conical bottomed platinum crucible (8).

Undoubtedly, the most important application of platinum in the glass industry is in the production of fiber glass, in which a platinum trough equipped with several hundred little

jets is employed for producing the glass filaments (9). With this arrangement, the temperature of the glass may be adjusted by passing electrical current directly through the platinum trough. The diameter of the glass fiber produced is very much smaller than the hole in the jet, as the hot glass fiber is stretched as it emerges from the orifice. However, both the diameter of the orifice and the viscosity of the glass, as well as the speed of withdrawal of the glass fiber, must be held within narrow limits to maintain the desired final diameter of the fiber.

In these applications of platinum, the actual consumption of metal is very small and the life is satisfactory where proper glasses are employed. However, glasses containing substantial amounts of lead, arsenic, and certain other reducible impurities may cause serious trouble under some conditions, particularly where the mixture is not very strongly oxidizing.

In equipment which is to operate at very high temperatures, ceramic supports are ordinarily preferred but, in some cases, base metals must be used; in the latter, the question of the inward diffusion of oxygen through the platinum and the outward diffusion of the base metal must be considered, and sometimes is a limitation. Methods are under development for minimizing these effects, but if a high alumina ceramic support can be employed this problem is avoided.

Platinum in Vacuum Tubes and Lamps

The fact that platinum does not oxidize on heating and possesses a relatively low thermal expansivity led to its early use in the production of metal-to-glass seals. The availability of this material made possible the early work in incandescent lamps by Edison and others, and in gas and electron discharge phenomena which ultimately led to the production of the x-ray tube, thermionic amplifiers, and cathode ray tubes. The use of platinum for lead-ins for incandescent lamps was a major use until about 1911, when it was supplanted by the use of the copper-clad nickel-iron alloy introduced by Fink and Eldred. In addition, a 5 per cent nickel-platinum alloy coated with barium and strontium oxides was used as a base for long life thermionic cathodes employed in telephone communication tubes with lives of the order of 50,000 hours. It might be remarked that this type of cathode is the only one known which can be reactivated after exposure to the atmosphere, and for this reason, cathodes of this nature are employed in certain types of ionization gauges.

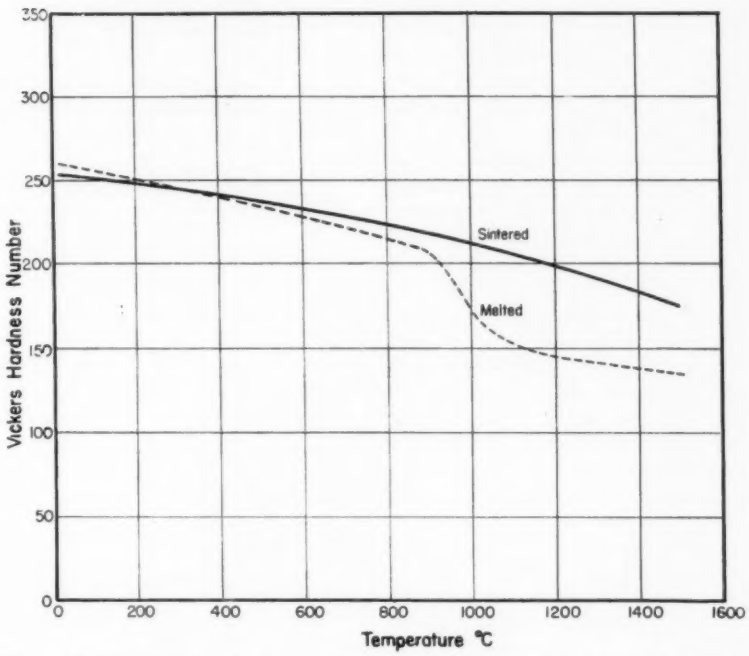

FIG. 1. Recrystallization behavior. 4% W-Pt, annealed 15 min, +92% cold work

Among the rather specialized uses, mention should be made of the high work function of pure platinum (about 6 electron volts). This characteristic of the pure metal and the absence of oxidation, and perhaps the ability of platinum to dissolve thorium and other low work function elements, account for the practically negligible grid emission observed in thermionic tubes equipped with platinum grids. Practically zero emission results even though the grid may be operating at high temperature, and this characteristic has been extensively employed in high power radar tubes of various types as well as in certain smaller tubes where grid emission is a problem. In most cases, platinum has been used in conjunction with thoriated cathodes, but in the smaller tubes it has been employed in conjunction with oxide coated cathodes. In the latter tubes, molybdenum wire clad with about 38 per cent by weight of platinum is employed, whereas in the larger tubes high purity 4 per cent tungsten platinum has proved most successful as it has higher mechanical properties than the pure platinum initially employed.

Electric Furnace Windings

Wire-wound laboratory electric furnaces operating at temperatures of 1100°C and above, particularly where oxidizing atmospheres are required, are frequently wound with platinum. The tendency has been to use pure platinum for the lower part of the temperature range or where the electrical resistance of the winding is to be used for controlling temperature. Ten and twenty per cent rhodium-platinum are used for windings for higher temperatures up to 1400 or 1500°C. The effects of temperature and atmosphere on the rate of volatilization of platinum and some of its alloys (10–13) are shown in Fig. 1.

Pyrometry

The 10 per cent rhodium—90 per cent platinum vs. pure platinum thermocouple, introduced by Le Chatalier, continues to provide the most convenient and accurate method for measuring high temperatures. The use of platinum resistance thermometers preceded the thermocouple, but was largely supplanted by the latter for a good many years. However, in recent years the merit of the resistance thermometer for measuring temperature below say 600°C has become better recognized, particularly where bridge methods are to be employed or where vacuum tube amplifiers are to be used. Nickel also is used for resistance thermometers up to about 250°C, but the curvature in resistance temperature relation as the Curie temperature is approached causes some complications, and for precise work at this temperature and above, the

platinum thermometer offers considerable advantage and is readily reproducible.

Electrical Contacts

The resistance of the platinum metals to oxidation and their high melting temperatures probably first suggested their use for electrical contacts in the very early days of electrical art. Switches, vibrators for Ruhmkorff coils, thermostats, telegraph keys and relays, and the like represented early uses and, with the advent of the gasoline engine, the use of platinum for contacts in magnetos rose to substantial levels. This use of platinum continues in aircraft magnetos where the 10 per cent ruthenium-platinum and the 25 per cent iridium-platinum alloys are preferred. With the availability of wrought tungsten and the development of battery ignition systems, the demand for platinum in automobile ignition systems dropped, but platinum is preferred for contacts in voltage regulators. One desirable combination for regulators is platinum for the positive electrode and tungsten for the negative, or 60 per cent osmium-40 per cent rhodium for the positive and 10 per cent ruthenium-platinum for the negative.

At one time, telephone relays required substantial amounts of platinum and gold alloys but, in recent years, palladium became available and has replaced these metals in such equipment. In this application, the major requirement is certainty of making and breaking contact and freedom from microphonic and other electrical noises which develop in contacts of silver and base metals due to sulfide or other films on the surface of the contact. These films generally possess non-ohmic characteristics, the resistance being substantially greater at low currents. Other requirements for this application are minimum rates of electrical erosion and slight tendency to transfer metal from one electrode to the other, which would cause trouble from sticking, etc.

In this application of palladium, the metal is generally applied by first welding it to a nickel strip and then welding the latter to the contact springs. In this way the palladium can be localized where it is needed and the amount required is minimized without impairing the life or reliability of the relay.

Rhodium also finds use in electrical contacts as an electrodeposited layer, generally over one of the other platinum metals where resistance to salt spray, etc., may be required. Such composite coatings have been very successfully used for tuning elements in certain radar equipment and allied devices where low pressure sliding contact is involved. Various wrought platinum metal alloys also find employment as sliding contact members, particularly in precision potentiometers where contact with chromium-nickel resistors is required and where the wear must be minimized. One type of alloy which has been very successful is a modified dental alloy containing platinum, palladium, gold, copper, and a little silver. This alloy can be hardened by thermal treatment and has been very successful in providing good contact without causing appreciable wear on the opposing resistor.

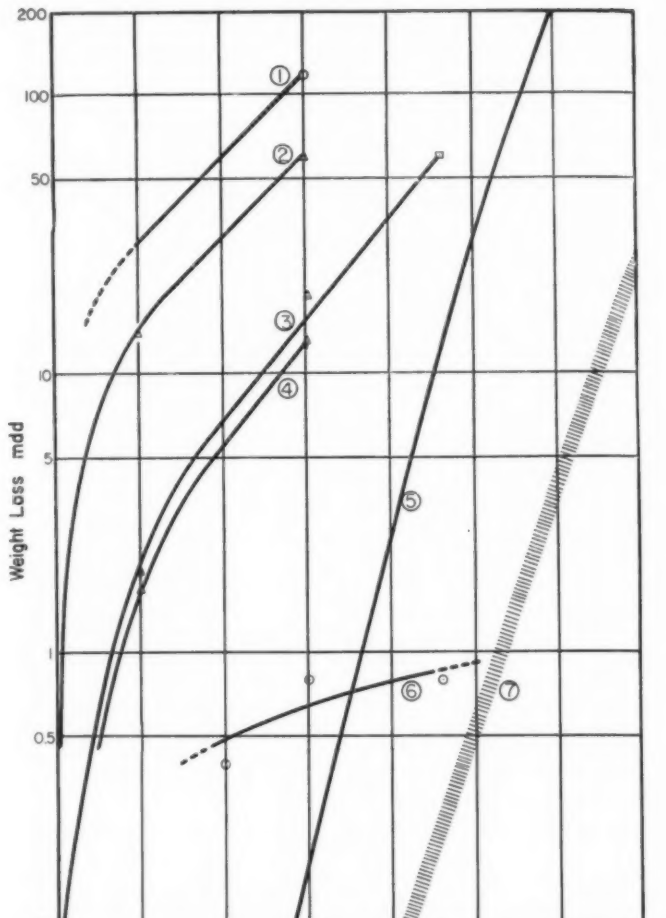

FIG. 2. Volatilization of platinum. Loss in moving air—(1) 5% Ru-Pt + 10% Ir-Pt; (2) 2.5% IrPt; (3) pure Pt; (4) 8% RhPt. Loss in vacuo—(5) pure Pt. Loss in still air—(6) pure Pt. Sources of data—⊙ C & L, △ B & W, □ K. Curve 5—Jones, Langmuir, and McKay.

Spark Plug Electrodes

To meet the increasingly severe demands on spark plugs for aircraft ignition, new types of plugs were brought out just prior to World War II, and these were highly developed and extensively used during the course of the war. One advantage of this plug is smooth running on lean mixtures, and for this and other reasons, perhaps 80 per cent of the world's flying is currently being done with this type of plug, embodying platinum alloy electrodes. The alloy in most extensive use contains 4 per cent of tungsten plus a little thoria and is produced by sintering in a manner similar to that employed by Wollaston over a hundred years ago. Wire so produced has a very high recrystallizing temperature and it has been found that by drastically cold working such material and employing it in the fibrous state, substantial resistance to attack by lead from fuel additives results, Fig. 2 (14). This appreciable tolerance

for lead made the spark plug a success and the corrosion resistance of platinum is such that relatively small diameter electrodes, in the neighborhood of .040 in., are suitable.

Methods for Applying Platinum Metal Coatings

Coatings of platinum can be applied to nonmetallic objects, such as glass and ceramics, by cathodic sputtering, vacuum distillation, or by the decomposition of organometallic compounds by heating. The latter process finds many uses in the scientific arts as the organometallic mixture known as "liquid bright platinum." It can be applied like a varnish, and after heating under oxidizing conditions to about 600°C leaves an adherent film upon the ceramic. Mixtures are available yielding films of nearly pure platinum or films of an alloy of gold and platinum usually containing small amounts of fluxing ingredients, such as bismuth and the like, and also films of platinum and silver. The latter had been particularly developed to provide a base which is readily soft-soldered without undue danger of dissolving the film during the process. Therefore, it is suitable for providing ceramic-to-metal seals and hermetic seals for capacitors and the like. Films of palladium have been applied in various ways to ceramics and used for electrical resistors, but the 56 per cent palladium-silver alloy has advantages as a resistor because of its higher resistivity and practically zero temperature coefficient of electrical resistivity.

Coatings of the ductile platinum metals can be applied to metallic surfaces by welding or, in certain cases, by electrodeposition, the latter being particularly suitable for the applications of thin coatings of rhodium and thin, as well as very heavy, coatings of palladium. Platinum also can be electrodeposited, but usually this method is confined to the production of rather thin coatings. Efforts to electrodeposit the other three platinum metals have not led to any useful application.

Rhodium, because of its high and maintained reflectivity, is employed for the production of mirrors, including the large 60 in. (152 cm) antiaircraft searchlight mirrors, and for small mirrors in optical devices, movie projectors, etc. Perhaps the major application of electrodeposited rhodium has been in the finishing of jewelry and similar objects where a nontarnishing finish of moderate cost is required. The successful baths for the electrodeposition of highly reflective and decorative coatings of rhodium are based upon the use of a soluble rhodium phosphate complex and with additional quantities of either phosphoric acid or sulfuric acid, as desired. The characteristics of the two types of baths do not differ greatly and both yield bright deposits, the reflectivity in the visible range being about 75 per cent (Table I) (15). Baths of other types are known, such as the straight sulfate and one based on the chloride, but the last is not suitable for the normal appearance applications of rhodium, although it is effective in depositing heavy layers of rhodium on noble metal surfaces.

TABLE I

(A) Rhodium bath for thin bright plates (15)

Rh as complex phosphate	2 g/l
H_2SO_4	20 cc/l

Operate at 40–45°C and a cathode current density of 50 amp/ft². Current efficiency will range from 5–12%.

(B) Rhodium bath for heavier plates (15)

Rh as sulfate	4 g/l
H_2SO_4	20 cc/l

Operate at 45°C with lead anodes and a cathode current density of 10–15 amp/ft².

(C) Soluble anode palladium tetranitrite bath (16)

Pd as $K_2Pd(NO_2)_4$	5 g/l
KCl	10 g/l

pH (glass electrode) preferably 6.0–6.5

Operate at 45°C and a cathode and anode current density of 4 amp/ft² and use cold-rolled high purity palladium anodes. Anode and cathode current efficiencies should be very close to 100%.

(D) Soluble anode palladium electroforming bath (17)

Pd as $PdCl_2$	50 g/l
NH_4Cl	20–50 g/l
HCl (37%) approx.	100 cc/l

pH (glass electrode) .0–.5

Operate at 50°C. Cathode current density 10 amp/ft²

Agitation—air lift

Use Pd anodes of very high purity, preferably melted under oxidizing conditions and cold rolled. Anode and cathode current efficiencies should be about 95%.

In the case of palladium, plating baths of the double alkali nitrite type provide a desirable low metal ion concentration, and if moderate amounts of chlorides or bromides are present, solution of the anode results, so that the bath is self-maintaining (Table I) (16). Thus far this characteristic has been limited to palladium baths and is a great convenience as it avoids the trouble of having to add special salts from time to time. This complex nitrite bath is suitable for deposits of moderate thickness, but where very heavy coatings are required or where electroforming to a thickness of 0.005 in. to 0.030 in. or more is desired, the high-purity palladous chloride bath is most suitable (Table I) (17). This bath also provides anode corrosion and is self-maintaining. It is, however, essential that the bath be free from other metals, particularly copper and silver, and that the anodes be of very high purity, and preferably made from palladium which has been melted under oxidizing conditions.

Anodes of High Hardness

While platinum and palladium are soft, of the same order as gold or silver, other metals of the group are harder, ruthenium and osmium being extremely hard. Indeed, alloys containing a total of 50 or 60 per cent of these last two metals are used for resisting wear in fountain pen tips, instrument pivots, long life phonograph needles, and some special types of small electrical contacts. These hard alloys are not ductile and, therefore, must be worked from the casting or be sintered approximately to shape. The major use of ruthenium, iridium, and rhodium is for hardening or otherwise modifying the properties of the wrought platinum and palladium alloys. The standard alloy for jewelry is about 4.5 per cent of ruthenium, with the balance being palladium. The 5 per cent and 10 per cent ruthenium-platinum alloys are used for electrical contacts and the former for jewelry as well. Iridium also is an excellent hardener for platinum, but weight for weight is only about half as effective a hardener as is ruthenium; the principal iridium-platinum alloys are the 5 per cent and 10 per cent iridium-platinum jewelry alloys and the 25 per cent iridium-platinum contact alloy. In platinum employed for crucibles, only small additions of other metals are made, about 0.6 per cent of iridium or 3.5 per cent rhodium, balance platinum, often being preferred to pure platinum. For other high temperature uses, including catalysts, glass feeding nozzles, and electrical resistance furnaces, the

rhodium-platinum alloys are preferred, the 10 per cent rhodium-platinum being the most extensively used with some use of the 20 per cent alloy for furnace windings operating at maximum temperatures.

Dental Alloys

Aside from the high-platinum alloys, whose uses have been mentioned earlier, considerable quantities of alloys are made in which moderate amounts of palladium or platinum are added to achieve special properties. The more important of these are the dental alloys which can be considered to be gold-silver-copper alloys modified by platinum or palladium, or palladium-silver-copper alloys modified by the addition of various amounts of gold (17). Both types of alloys are used in dentistry, those used in the first group providing the high strength, light yellowish alloys used for structural parts and orthodontic wires, and also many of the casting golds. The second group, containing higher palladium, constitute the white alloys used principally for casting. Both groups are responsive to age-hardening heat treatments, and some of the high strength wrought alloys develop a tensile strength of the order of 160,000 psi after a simple age-hardening treatment.

The most generally applicable method for applying very thin films of the platinum metals is to evaporate them in a vacuum of 10^{-4} millimeters or better. Films of rhodium a few angstroms thick, used for semitransmitting mirrors, have been produced in this way, as well as heavier films suitable for reflectors. In metal evaporation, it frequently is the practice to support the metal on tungsten or other refractory wire, but in the case of rhodium, the temperatures required are so high that it is necessary to evaporate the rhodium directly from a sheet of the material which is electrically heated to within a few degrees of its melting temperature.

TABLE II. *Properties of high purity precious metals* (4, 18, 19)

Name	Atomic weight	Density g/cm³ at 20°C	Structure	Lattice constant (A), kx	Melting point, °C	Boiling point, °C	Thermal expansivity per °C × 10⁶ at 20°C	Thermal conductivity at 20°C, C.G.S.
Platinum	195.2	21.45	F.C.C.	3.916	1773	4530	8.9	0.166
Iridium	193.1	22.5	F.C.C.	3.831	2454	5300	6.8	0.14
Osmium	190.2	22.6	Hex.	2.73 c/a = 1.58	2700	5500	5.5 (approx.)	
Palladium	106.7	12.0	F.C.C.	3.882	1554	3980	11.8	0.168
Rhodium	102.9	12.4	F.C.C.	3.796	1966	4500	8.3	0.21
Ruthenium	101.7	12.2	Hex.	2.70 c/a = 1.59	2500	4900	9.1	
Gold	197.2	19.32	F.C.C.	4.070	1063.0	2970	14.2	0.71
Silver	107.9	10.5	F.C.C.	4.078	960.5	2212	20.	1.0

Name	Electrical resistivity, microhm-cm		Temperature coefficient, 0°–100°C	Annealed hardness, VHN	Annealed tensile strength, lb/in.²	Tensile modulus, lb/in.² × 10⁻⁶	Reflectivity at various wave lengths		
	0°C	20°C					450 μμ, %	550 μμ, %	750 μμ, %
Platinum	9.8	10.6	0.00392	39	18,000	22	55	60–65	71
Iridium	4.9	5.3	0.004	170		76	64	70	78
Osmium	8.9	9.5	0.0042	400		81			
Palladium	10.0	10.8	0.0038	38	20,000	17	54	60–63	66
Rhodium	4.3	4.7	0.0044	120	73,000	50	78	79	80
Ruthenium	7.6	8.3	0.0046	390		60	—	circa 63	—
Gold	2.19	2.35	0.004	25	19,000	11	37	65	94
Silver	1.59	1.72	0.0041	25	18,000	11	90	95	97

TABLE III. *Properties of some commercial alloys (annealed)* (4, 18, 19)

Name	Density, g/cm³ at 20°C	Electrical resistivity microhm-cm at 20°C	Temperature coefficient, 20–100°C	Hardness	Tensile strength annealed lb/in.²	Elongation, %
Crucible grade Pt (99.5 + Pt)	21.4	11.4	0.0035	50 VHN	24,000	30
10% Rh Pt	19.97	19.2	0.0017	90 BHN	45,000	35
20% Rh Pt	18.74	20.8	0.0014	120 BHN	70,000	40
10% Ir Pt	21.53	25.0	0.0013	130 BHN	55,000	25
25% Ir Pt	21.66	33.0	0.0006	240 BHN	125,000	20
5% Ru Pt	20.67	31.5	0.0009	130 BHN	60,000	34
10% Ru Pt	19.94	43.0	0.0008	190 BHN	85,000	31
4% W Pt	21.3	36.5	—	150 VHN	75,000	25
Palladium	12.0	10.8	0.0034	50 VHN	30,000	30
4½% Ru Pd	12.0	23.5	0.0013	85 VHN	50,000	25
40% Ag Pd	11.3	42.0	0.00002	100 VHN	51,000	47
40% Cu Pd	10.6	35.0 Quenched 3.5 Ordered	0.00032 0.00224		75,000	

In connection with age-hardening, it seems quite certain that this process was first applied to the precious metal alloys rather than to the aluminum alloys of the Duralumin type, although this fact seems to be little known.

Jewelry

The use of platinum for jewelry is a relatively recent development, having been important for less than 50 years, whereas the use of gold and silver for ornamental purposes has been practiced for thousands of years. Platinum, generally hardened with iridium or ruthenium, is used for a variety of jewelry, but most of it has been in connection with gem-set jewelry, particularly diamond-set objects. The appearance of such jewelry is enhanced by the use of a white metal, and the strength and freedom from cracking of the platinum alloy insures the secure retention of the precious stones without requiring heavy and clumsy mountings. Palladium has always been rarer than platinum and, until recent years, insufficient quantities were available to permit it to be used for jewelry, but in the last fifteen years, larger amounts of palladium have been produced so that it is now used for a wide variety of jewelry and frequently as mountings on gold jewelry where the white color and mechanical properties of the ruthenium-palladium alloys are desirable.

As was mentioned earlier, rhodium also finds use in the jewelry industry as a finishing plate for a variety of metals, including silver, where its whiteness and freedom from tarnish are required.

Summary of Properties

The properties of the six platinum metals are summarized in Tables II and III (4, 18, 19), and it will be seen that these elements arrange themselves in two triads differing about two to one in density. The heavy group comprises platinum, iridium, and osmium, the latter with a density of 22.6 probably being the densest element known, and the lighter group comprising palladium, rhodium, and ruthenium, which have densities of the order of 12. The first members of each group are extremely ductile and have tensile strengths of the order of 20,000 psi when annealed. The next pair, iridium and rhodium, are more difficult to work, iridium particularly, while the last pair, osmium and ruthenium, are substantially unworkable. Palladium and platinum are the most abundant but still are about 100 times as rare as gold. The other metals of the group are even rarer, osmium being the least common.

For many applications it is desirable to harden the platinum or palladium, and this is best done by adding another member of the platinum family, the production of these other elements being sufficient to permit production of the desirable alloys. It is remarkable how self-integrated is this little group of six elements, each serving to complement the other and to provide the properties required in the various industrial and appearance applications.

Corrosion resistance is definitely a factor in most of the applications of these metals and alloys. Considerable data exist regarding their corrosion behavior and most of this has been summarized in appropriate sections of The Electrochemical Society's "Corrosion Handbook" (5).

High temperature corrosion often is important and, in some cases, the temperatures are such that volatilization becomes a factor. Fortunately, the vapor pressure of platinum is low, the boiling point being about 4500°C. The rate of evaporation in vacuo has been determined by Jones, Langmuir, and Mackay (11) and is shown in Fig. 1. The effect of the atmosphere on the evaporation of platinum is appreciable and certain experimental data are summarized in this figure. In general, it appears that a moving oxidizing atmosphere results in some increase in the rate of evaporation of platinum, but the problem is by no means simple, and considerable work is being done to clarify the situation and indicate means for minimizing evaporation at very high temperatures. In the case of electrical

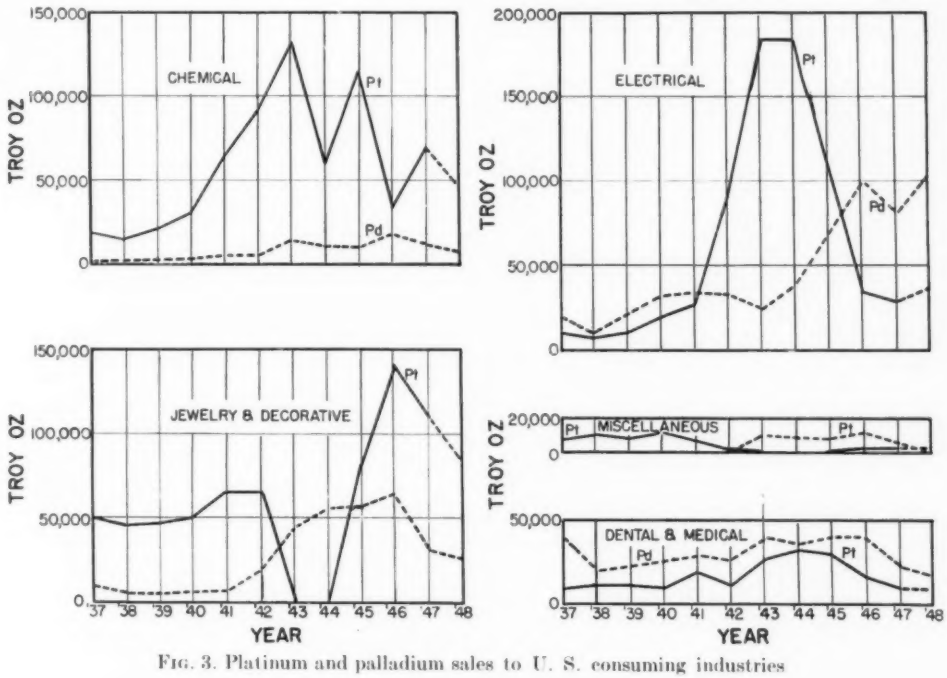

FIG. 3. Platinum and palladium sales to U. S. consuming industries

resistance furnaces, evaporation of the winding may determine its life, but does not necessarily result in appreciable metal loss as most of the sublimed metal can be recovered from the surrounding refractory.

In the case of resistance thermometers and thermocouples, changes in composition resulting from selective evaporation or, more generally, contamination acquired from the surroundings, are important. The bad effect of reducing atmospheres on these devices is principally due to the fact that such atmospheres may reduce silicon and other dubious materials from the surroundings. Platinum, even at high temperature, is not disturbed by exposure to SO_2, in sharp contrast with practically all other metals. However, rhodium-platinum may be less tolerant of sulfur and some work done on thermocouple deterioration under very exaggerated conditions has suggested that the co-presence of sulfur aggravated the difficulty from silicon contamination under reducing atmospheres (20).

Platinum behaves well in contact with the halogens at ordinary temperatures, but at elevated temperatures volatile chlorides are formed which result in appreciable rate of attack. However, platinum is not damaged by HCl even at high temperatures, and large-scale equipment is in operation which is subjected to this gas together with carbonaceous and other impurities, without appreciable attack.

Platinum also behaves well in contact with mercury. It is a little difficult to amalgamate the platinum, but it can be done and does not result in any damage to the metal but does insure the excellent electrical contact with mercury essential to certain types of switches. The actual solubility of platinum in mercury is so low that its determination is extremely difficult and prolonged refluxing is required to secure a weighable result. The value for platinum at 160°C, as obtained in this manner by C. H. Prescott (21), is 4.6×10^{-9} grams Pt/grams Hg. Palladium shows more reaction with mercury, but it may be low enough to make palladium useful in contact with mercury under some circumstances.

Sources of Platinum Metals

The major producers of platinum in recent years, approximately in the order of importance, are Canada, Russia, South Africa, Colombia, and Alaska.

Canada is the principal producer of palladium, but both the Belgian Congo and South Africa produce considerable amounts. Since the war, Russia has sold substantial amounts and at times has followed Canada in sales.

The major source of both rhodium and ruthenium is Canada, while the sources of iridium and osmium are varied, some native platinum containing considerable iridium while small amounts of osmi-iridium are found in placers and some is associated with gold in the large South African gold mines.

Distribution of Uses

The United States is the largest consumer of platinum metals, as it is of other metals, so that a study of the distribution if its use of these versatile metals is important. Data summarized by the U. S. Bureau of Mines are given in Fig. 3. It must be recognized, however, that the distribution of consumption in other parts of the world differs from that in the United States. It also should be recognized that the war had a marked effect upon uses: for example, the temporary restriction of the use of platinum in jewelry.

References

1. W. H. Wollaston, Bakerian Lecture, 1828, *Phil. Trans.*, 119 (1829).
2. H. Sainte-Claire Deville and H. Debray, "Du Platine et des Meteaux Qui L'Accompagnent," Mallet-Bachelier, Paris (1859).
3. S. L. Handforth and J. N. Tilley, *Ind. Eng. Chem.*, **26,** 1287 (1934).
4. R. F. Vines and E. M. Wise, Editors, "Platinum Metals and Their Alloys," The International Nickel Co., Inc., New York (1941).
5. H. H. Uhlig, Editor, "Corrosion Handbook," John Wiley & Sons, Inc., New York (1948).
6. G. P. Gladis, Research Lab., The International Nickel Co., Inc., Unpublished Report.
7. H. K. Richardson, *J. Am. Ceram. Soc.*, **17,** 236 (1938).
8. D. C. Stockbarger, *Rev. Sci. Instruments*, **7,** 133 (1936).
9. Games Slayter, *Rayon Textile Monthly*, **18,** 301 (1937).
10. G. K. Burgess and R. G. Waltenberg, *Nat. Bur. Standards U. S., Sci. Paper #280*, (1916).
11. A. Jones, I. Langmuir, and G. M. J. Mackay, *Phys. Rev.*, **30,** 201 (1927).
12. O. Kubaschewski, *Z. Electrochem.*, **49,** 446 (1943).
13. F. E. Carter and A. J. Lincoln, Research Lab., Baker & Co., Inc., Newark, N. J., Private Communication.
14. Unpublished Research, Platinum Metals Lab., Mond Nickel Co., Ltd., London, England.
15. T. P. Shields, U. S. Pat. 1,949,131, Feb. 27, 1934.
    F. Zimmerman and H. E. Zschiegner, U. S. Pat. 1,981,820, Nov. 20, 1934.
16. E. M. Wise, U. S. Pat. 1,970,950, Aug. 21, 1934.
    A. R. Raper, U. S. Pat. 1,993,623, Mar. 5, 1935.
17. E. M. Wise and R. F. Vines, U. S. Pat. 2,335,821, Nov. 30, 1943 and 2,457,021, Dec. 21, 1948.
18. T. Lyman, Editor, "National Metals Handbook," American Society for Metals, Cleveland, Ohio (1948).
19. E. Raub, "Die Edelmetalle und ihre Legierungen," Julius Springer, Berlin (1940).
20. J. C. Chaston, R. A. Edwards, and F. M. Lever, "Embrittlement of Platinum and Platinum Rhodium Thermocouples," *J. Iron Steel Inst. London*, **155,** Part 2, 229 (1947).
21. C. H. Prescott, *Bell Labs. Record*, **21,** 104 (1942).

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Theoretical Electrochemistry — Electrothermics — Electric Insulation
Rare Metals — Luminescence — Industrial Electrolytics — Instrumentation

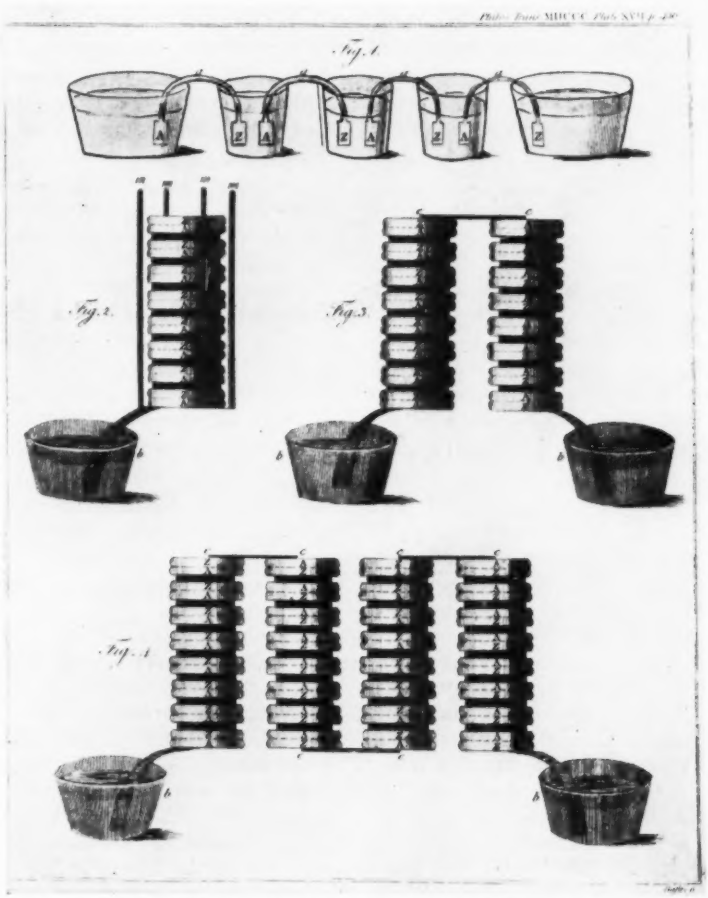
A Note on the One Hundred and Fiftieth Anniversary of the Voltaic Pile

*George W. Heise**

The following note recalls that the first scientific report of the construction of a primary electric battery was sent 150 years ago by Alexander Volta to the Royal Society. No one at that time could have foreseen the manifold applications that would be made of Volta's discovery. The rapid advances which were made in the knowledge of the nature of electricity in the years immediately following were the result, in large part, of a free exchange of information between scientists from many countries. The Electrochemical Society is proud of its share in carrying on today this essential contribution to the continued advance of electrochemical knowledge.—Ed.

Alessandro Volta's letter[1] describing the first primary electric battery was sent to Sir Joseph Banks, President of the Royal Society under date of March 20, 1800, and read before the Society on June 26 of the same year. But long before its publication, the letter was brought to the attention of other investigators, among them William Nicholson and Sir Anthony Carlisle who, as early as July 1800, announced the decomposition of water by current from a Volta pile, thus[2]:

"On the second of May we, therefore, inserted a brass wire through each of two corks inserted in a glass tube of half an inch internal diameter. The tube was filled with New River water, and the distance between the points of the wires in the water was one inch and three quarters. This compound discharger was applied so that the external ends of its wire were in contact with the two extreme plates of a pile of thirty-six half crowns with the correspondent pieces of zinc and pasteboard. A fine stream of minute bubbles immediately began to flow from the point of the lower wire in the tube, which communicated with the silver, and the opposite point of the upper wire became tarnished, first deep orange and then black. On reversing the tube, the gas came from the other point."



Copy of original plate showing Volta batteries (*Phil. Trans.*, 1800)

Editorial discussion in *Chemistry and Industry*[3] some years ago of the work of Nicholson and Carlisle brought the following comment[4]:

"I confess I have not repeated their

* National Carbon Research Laboratories, Cleveland, Ohio.

[1] On the Electricity excited by mere Contact of conducting Substances of different kinds. ALEXANDER VOLTA, *Phil. Trans. Roy., Soc.*, **90**, 403-31 (1800).

[2] W. NICHOLSON, "Account of the New Electrical or Galvanic Apparatus of Sig. Alex. Volta and Experiments performed with the same," *Nicholson's Journal of Natural Philosophy, Chemistry and the Arts*, July 1800.

[3] *Chemistry and Industry*, **62**, 362 (1943).

[4] J. T. CRENNELL, *ibid*, 397 (1943).

experiment with a pile of 36 half-crowns, but I am prepared to wager as many that if it were done the (hydrogen) bubbles would come from the wire connected to the zinc."

In the terms of the modern primary battery, the observation would, of course, have been correct. But, alas, Volta and, for that matter, his followers, for many decades after his discovery, held that the current originated merely from the contact of dissimilar conductors, "*electricité excitée par le simple contact mutuel des metaux de différente espèce, et même par celui des autres conducteurs. . . .*"[5] his battery being described as a series of metallic couples, e.g., zinc: silver, separated, in the "*pile*" by moistened sheets of bibulous non-conducting material ("*disques mouillés*"), in the "*couronne de tasses*" by liquid electrolyte. In consequence, as clearly shown in the plate attached to Volta's paper, each battery had at least two superfluous metal pieces, zinc at one end, silver at the other; and contact with a zinc terminal actually made connection with the silver electrode, and vice versa.

That Nicholson and Carlisle actually copied Volta's construction using pairs of dissimilar metals in dry contact, with an inactive zinc at one end, and an unnecessary silver disk at the other, is definitely established by their own description[6] of their cell from which I quote:

"On the 30th of April, Mr. Carlisle had provided a pile consisting of 17 half crowns, with a like number of pieces of zinc, and of pasteboard, soaked in salt water. These were arranged in the order of silver, zinc, card, etc. which order I shall denote by saying, that the silver was undermost, that is to say, under the zinc; and I make this remark because some philosophers have used the expression that the silver was undermost when they used the order of silver, card, zinc, etc. which, as the reader will easily perceive, is contrary to the order here spoken of. This is of no consequence to the effect, though it is material to a clear understanding of the terms we use."

Thus the original observation of Nicholson and Carlisle was not in error, and the reputation of these worthy investigators, and the foundations of our science, rest secure.

[5] VOLTA, *loc. cit.*, p. 403.
[6] NICHOLSON, *loc. cit.*

The Present Status of Titanium Metal

*Felix B. Litton**

The first step in producing titanium metal from its ores is the production of relatively pure titanium dioxide. The principal use of titanium dioxide is in the paint and pigment industries, and, consequently, those industries are presently concerned with the promotion of titanium metal for commercial use.

In 1946, the Bureau of Mines critically reviewed all the processes which had been proposed for producing titanium metal, and it was concluded that the reduction of titanium tetrachloride with molten magnesium, as proposed by Kroll, was potentially the most practical method for large-scale production. In 1948, the Du Pont Company began commercial production of titanium sponge containing less than 0.5 per cent impurities. The sale price was $5.00 per pound and initial production was 100 pounds per day.

Basically, the Kroll process consists of causing a halide of titanium to react chemically with an alkaline earth metal at an elevated temperature below the boiling temperature of the metal and in the presence of a protective gas at normal pressure. The reaction mass is then pulverized, and the salt removed by leaching. The titanium metal powder thus liberated is compacted and sintered at high temperatures under an inert atmosphere.

The Du Pont Company uses a modified Kroll process for producing titanium sponge. Molten magnesium is reacted at 700°C under an inert atmosphere at normal pressure with purified titanium tetrachloride. The reaction mass is broken up and the undesired components vaporized from the titanium at elevated temperature and reduced pressure. The sponge is then melted under an inert atmosphere in carbon crucibles.

It will be noted that the Kroll process is a batch process involving a number of operations. Therefore it is a costly process, and each step must be controlled accurately, in order to produce metal of consistent and uniform quality. Since 1948, the Du Pont product has progressively improved.

Of potential commercial importance is the so-called iodide process. The iodide process was proposed by van Arkel in Holland about 1925 for producing relatively pure zirconium and titanium metal, and is of particular interest at the present time for obtaining data on the properties of relatively pure metal and its alloys.

The iodide process consists of reacting iodine at elevated temperature with crude titanium to form titanium iodide. The iodide, being unstable at temperatures above approximately 1100°C, is then decomposed on a heated surface to form relatively pure titanium and free iodine. The freed iodine reacts with more crude titanium and the reactions involved are again repeated.

Research Activity

Both methods described herein for manufacturing titanium metal are complicated batch operations. However, enough information has been obtained on the character of titanium and some of its alloys to visualize a large potential market. Obviously, the scope of the commercial applications will depend primarily on economic factors. It is likely that the preferred large-scale commercial method for titanium production has not yet been developed. It is postulated that such a process will proceed directly from a crude titanium compound to high purity titanium ingot. Simple methods for direct alloy formation will be improvised and incor-

* Foote Mineral Company, Philadelphia, Pa. Excerpts from an address delivered before the Philadelphia Section of The Electrochemical Society on January 11, 1950.

porated. It is believed that a modified iodide process has more inherent promise for achieving this objective than other processes proposed up to this time.

Properties of Titanium

A compilation of some of the physical properties of relatively pure titanium are as follows:

Density—4.50 g/cm³
Atomic weight—47.90
Atomic number—22
Melting temperature—1725°C ± 10°
Crystal structure—Hexagon close packed
a 2.946 Å
c 4.686 Å
c/a 1.591 Å
—Body centered cubic
a 3.32 Å
Transformation from H.C.P. to B.C.C. —882°C ± 10°
Boiling temperature—3000°C
Resistivity—42 × 10^{-6} ohm-cm
Temperature coefficient of resistivity —5.46 × 10^{-3} ohm per °C
Coefficient of thermal expansion—8.2 ×10^{-6} in. per °C
Specific heat—0.1386 cal per gram

The mechanical properties of titanium are greatly influenced by impurities absorbed during the manufacturing process. Nitrogen and oxygen appreciably increase the hardness and strength, and correspondingly decrease the ductility of the metal. A typical comparison of arc-melted rolled and annealed iodide and magnesium-reduced metal is as follows:

	Iodide	*Magnesium-reduced*
Ultimate strength, psi	43,000	80,000
Yield strength, psi 0.2%	22,000	72,000
Elongation, % in 2 inches	40	25
Reduction in area, %	75	55

A more direct comparison of titanium produced by the two processes can be made by hardness measurements on arc melted ingots. The hardness of melted iodide metal is generally below Rockwell A 30, whereas magnesium-reduced metal has a hardness generally above Rockwell A 55.

The amount of cold reduction that an ingot will absorb without fracture is related to the initial ingot hardness. Melted iodide titanium can be cold rolled to 95 per cent reduction without edge cracking, whereas magnesium-reduced metal will absorb only approximately 50 per cent reduction. The two metals work harden to approximately the same hardness value, that is, Rockwell B 100.

The formability of iodide titanium is superior to the magnesium-reduced metal. At present, the magnesium-reduced product does not appear satisfactory in applications where deep drawing and severe forming properties are required.

Melting Techniques

As molten titanium reacts with all common refractory crucible materials, the problem of consolidating the metal contamination has resulted in the development of special melting techniques.

The Bureau of Mines advocates powder-metal methods in which the metal is consolidated at temperatures below the melting point. The Du Pont Company melts in graphite crucibles in an induction furnace under a purified inert atmosphere. This procedure results in carbon contamination ranging from 0.25 to approximately 2.0 per cent, depending on time-temperature relationships. Carbon contamination is not as deleterious as nitrogen and oxygen absorption on the mechanical properties of titanium. Du Pont is commercially producing 400-lb ingots. Battelle advocated melting titanium in an arc under a purified inert atmosphere on a water cooled copper crucible. The latter procedure was observed to be most satisfactory in research work on titanium in the laboratory of the Foote Mineral Company.

Miscellaneous Properties

Commercial titanium is hot-worked in air up to its transformation temperature. A thin titanium-oxygen layer is formed which does not seriously penetrate into the metal. Nitrogen does not appear to enter into the oxidation-relation at temperatures below the transformation. The titanium-oxygen layer is removed by grinding before the final cold-rolling operation. It has been reported that heavy titanium sections may be forged above the transformation range, but it is generally believed that excess nitrogen and oxygen absorption occurs when this practice is followed. Commercial titanium can contain relatively large amounts of nitrogen and oxygen without impairing its rollability at relatively high temperatures. Titanium can be surface-hardened by diffusing oxygen to controlled depths.

Titanium is reported to have excellent corrosion resistance. Laboratory tests show that the metal is resistant to nitric acid, aqua regia, chlorine, dilute hydrochloric and sulfuric acids, and sodium hydroxide. It is comparable to some of the most corrosion-resistant materials to sea water.

Room-temperature creep data indicate that titanium has a high creep rate. Its resistance to secondary creep was improved by cold reduction, but remained higher than iron, stainless steel, and aluminum alloys.

Titanium can be spot-welded using conditions generally employed for stainless steel. Chemical treatment of the surface is not necessary, but heavy oxide should be removed by grinding. The metal can be arc-welded under a protective unit atmosphere.

Titanium Alloys

Titanium is capable of forming satisfactory alloys with a wide range of elements. Some of the elements appear to impart special properties, such as improved corrosion or resistance. Almost any element will strengthen titanium.

Titanium is so extremely difficult to prepare in the pure form that the magnesium-reduced commercial variety may be considered an alloy containing variable percentages of oxygen and nitrogen. The total oxygen and nitrogen content is generally less than 0.3 per cent. Yet, from low to high composition variation, the ultimate strength may increase from 60,000 to 100,000 psi on annealed specimens, depending on the analyses of the particular lot. Oxygen and nitrogen are important alloying elements, and the relative amounts present primarily account for differences reported between iodide and magnesium-reduced metal.

Chromium, tungsten, and molybdenum can be added to titanium to form relatively higher strength alloys than obtained through addition of similar amounts of other metallic elements. In the low-alloy range, that is up to 10 per cent, chromium forms higher strength alloys than tungsten and molybdenum. By controlling the oxygen and nitrogen content, chromium-titanium alloys have been made which have ultimate strengths approaching 200,000 psi.

Conclusion

The natural location of ilmenite deposits and an established titanium dioxide pigment industry insures the United States a continued source of raw material for titanium metal manufacture.

Even though the metal at present is produced commercially by reducing the tetrachloride with magnesium, it is believed that a continuous method will

eventually be developed which will make the batch type operation obsolete. The mechanical properties of the commercial metal depend primarily on its purity, and, consequently, there will probably be several grades of the metal available to industry.

Titanium has many potential uses. Its largest visualized use is in the construction of mobile equipment where it fills a gap between aluminum and iron. The present price of titanium must be reduced to $1.00 per pound before the metal will find widespread industrial application. Its niche is undoubtedly in the construction of aircraft, naval, railway, and automotive equipment.

A market for titanium at its present price is developing. These uses are required by the armed services and are based on special properties of the metal, such as its ability to withstand corrosion without pitting, a defect of stainless steel, and its strength at intermediate temperatures, the primary drawback to the use of aluminum and magnesium alloys. The metal's abrasion resistance and ability to be surface hardened in conjunction with its light weight may also be considered a special property. Low thermal expansion and poor heat conduction suggest its use in jet and reciprocating engine components.

The present principal sale for titanium appears to be to the armed services for development purposes. Each day more and more information is being obtained on the properties of the metal and its alloys by both Government and industrial employees. Research men are trying new and improved techniques for manufacturing, and when the large-scale method is developed, a market will be available for this relatively new and unusual metal.

Der Internationale Scientist

I. Der Franklin und sein Keit

Sol Neman

• We have had several communications from the eminent electrochemist Prof. Dr. Sol Neman, expressing great concern over the inaccuracies which have crept into our concepts, particularly with respect to the history of our science. To emphasize his point, he has offered us the only true version—which he designates euphemistically as the "Lohdaun"—of Benjamin Franklin's classic work on atmospheric electricity. He is particularly anxious to have us note that his contribution shows the classic purity of his native tongue, not the corrupted jargon which has become current in the land of his birth since he emigrated to the U. S. A.

We admit that we had entertained some fears lest this historical note mark the beginning of a series, but the Professor has reassured us on this score, pointing out that his scientific labors—he is at present engaged, *inter alia*, in translating the "Corrosion Handbook" into his own language—would in any event make impossible more than a brief communication "wanz in a Weil."—Ed.

* * *

Der Franklin der war ein rechter Tschinius, immer bissig mit Inwentschiuns wie zum Beispiel sein Stohf, den wir bis heute noch bei seinem Namen kennen. "Bei Galli," so meinte er eines Tages, "es ist doch e' Skandal und e' Schehm, dass so viele Haeuser von Leitning gestreikt werden. Wenn

ich das prewenten koennte, es waere schuhr eine kuehle Million wert. Aber was ist denneigentlich der Leitning? Ennihau, ich habe e' Honntsch."

Also baut er e' Keit, mit einer langen String mit e' Kieh am Ende, und geht in die Beckjahrt, ihn zu fleihen. Und wie es zu regnen anfaengt, und der Leitning flescht, so steckt er e' Knockel an den Kieh, und achherrjesses! der Spark rippt ihm Zwei Fingernehls und e' Viertelskwerrfuss Skinn von der Hand ab, und der Franklin weiss nun, von dem Schock, Dass Leitning und Elektrizitaet alleik sind.

Sodann steigt er auf die Ruf mit e' Bumberschuht mit e' Stiehl Haendel, und wartet fuer mehr Leitning; aber die Deborah,—das war seine Frau,—die hollert, sein Sopper sei rettig, und er soll Hoerriopp machen und aufwaschen und ins Haus kommen. Also macht er den Bumberschuht an den Daunspaut fest, . . . und das war der erste Leitningrad.

Der Franklin war lockig, und so lebte er noch vierzig Jahre und hat alle gefaessinetet—besonders die Lehdis—aber ein russischer Physiker, der den Keitexperiment repieten wollte, wurde vom Leitning gekillt,* . . . was alles pruhft, der wahre Scientist hat nicht senns genug, von dem Rehn auszukiepen.

Next: "Der Volta und seine Peils."

* Another Russian "first"?—Ed.

NOTICE TO MEMBERS

By now you have received your official voting ballot from Society headquarters. If you have not already done so, please return the ballot as soon as possible so that your vote may be included in the final election count.

Cleveland Convention, April 19–22, 1950

The forthcoming ninety-seventh meeting of the Society promises four full days for all electrochemists who will be able to attend. The meeting will be held in Cleveland, Ohio, April 19th through 22nd, and headquarters will be at the Hotel Statler.

An interesting program of varied technical papers, plant trips, and entertainment should make this meeting an important event for all members of the Society.

Technical Program

Those who are planning the symposia for the Convention have promised interesting sessions covering the fields of Theoretical Electrochemistry, Electrothermics, Luminescence, Rare Metals, Electric Insulation, Industrial Electrolytics, and Instrumentation.

Of special interest to all attending will be the session on Theoretical Electrochemistry. Among papers being listed for this program are: "Anode Effect in Aqueous Electrolysis" by Herbert H. Kellogg; "On the Determination of the Roughness of Metallic Surfaces" by Carl Wagner; "Nitric Acid-Nitrous Acid Concentration Cells" by William Cabler Moore; and two new papers on the "Electrodeposition Behavior of a Simple Ion" by L. B. Rogers.

As in the past, the members of the Electronics Division have done a fine job in planning a symposium on Luminescence. Some of the papers to be presented under the sponsorship of this Division will be:

"Effect of Thermal History on Color of Zinc Beryllium Silicate (Mn) Phosphors" by Shannon Jones

"The Origin of Multiple Bands in Luminophors Activated by Divalent Manganese" by F. A. Kroeger and P. Zalm

"The Fluorescence of Magnesium Germanate Activated by Manganese" by F. A. Kroeger and J. van den Boomgaard

"Barium - Magnesium Silicate Phosphors" by Keith H. Butler and James G. Cassanos

"Calcium Antimonates" by Keith H. Butler, Martha J. Bergin, and Virginia M. B. Hannaford

"A Study of the Mechanism of Sensitized Luminescence of Solids" by James H. Schulman, R. J. Ginther, and C. C. Klick

"Spiraling in Fluorescent Lamps" by R. van Male de Ghorain and A. Luyckx.

In addition to the symposium on Luminescence, the Electronics Division is also planning a well-rounded program on Rare Metals. Among papers to be included in this session will be:

"A Review of the System Vanadium-Oxygen" by N. P. Allen

"Evaluation of the Quality of Germanium by Electrical Methods" by W. C. Dunlap

"The Properties and Uses of Thallium" by H. E. Howe and A. A. Smith, Jr.

"Palladium Plating Baths for Heavy Deposits and Electroforming" by E. M. Wise and R. F. Vines.

The session on Electrothermics will include, among others, the following interesting papers:

"Vapor Pressure of Beryllium Oxide" by N. D. Erway and R. L. Seifert

"Refractories for Four Thousand Degrees Plus" by Gordon R. Finlay

"Production of Fused Stabilized Zirconia" by D. W. Marshall

"Electrothermal Preparation of Pure Crystalline Boron, Boron Nitride, and Boron Carbide, and their Characteristics" by Eugene Ryshkewitch

"Metal Ceramics for High Temperature Applications" by W. O. Sweeny

"Phase Relationships in the Binary Systems of Nitrides and Carbides of Zirconium, Columbium, Titanium, and Vanadium" by Pol Duwez and Francis Odell

"Effect of Chromium on the Oxidation Resistance of Titanium Carbide" by John D. Roach

"Soldering to Ceramics and Nonmetals" by R. J. Bondley.

A complete list of the papers to be presented at the various symposia will be published in the April issue of the JOURNAL.

GEORGE W. HEISE
Honorary Chairman, Cleveland Convention

C. C. ROSE
Vice-Chairman of Convention

Registration

Registration has been scheduled for 8:30 A.M. through 5:00 P.M. on Wednesday, 8:00 A.M. through 5:00 P.M.

LEO PUCHER
Chairman, Registration

WILLIAM G. HARVEY
Banquet Toastmaster

ROBERT C. HEINTON
Chairman, Plant Visits

on Thursday and Friday, and 8:30 A.M. through 12:00 Noon on Saturday.

Registration fees at the time of the Convention will be:

Members	$5.00
Ladies	2.00
Students	1.00
Nonmembers not included above	7.00
Saturday morning only	1.00

Of special interest to the members will be the fact that the Cleveland Committee has planned to keep at a minimum prices for registration, luncheons and dinners, plant trips, and the various entertainment features.

Annual Banquet

Preceding the Annual Banquet, to be held at 7:00 P.M. on Thursday, April 20th, will be a reception for President and Mrs. A. L. Ferguson. Former president W. G. Harvey, well known to many members of the Society, will act as toastmaster at the banquet. The featured event will be the presidential address, delivered by Dr. Ferguson.

Plant Trips

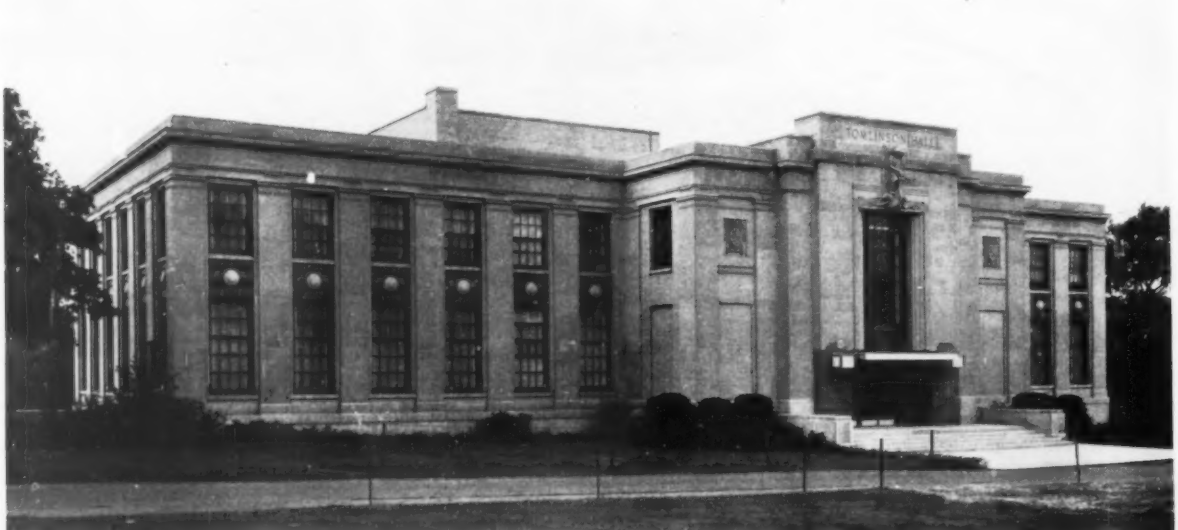
Electrochemists attending the Cleveland Meeting will have an opportunity to visit two well-known laboratories—the Lewis Flight Propulsion Laboratory of the National Advisory Committee for Aeronautics, and the B.F. Goodrich Research Center. Details about these plant visits were published in the February issue of the JOURNAL.

Plan Informal Entertainment

An informal evening of entertainment in the lighter vein is scheduled for Friday, starting with a cocktail hour at 6:00 P.M. and followed by dinner in the Statler Ball Room at 7:00.

Feature entertainer of the evening will be Stuart Cramer, described as a "Magical Mirthmaker." Mr. Cramer, who has entertained audiences in vari-

Continued on page 80C)



TOMLINSON HALL, NEW STUDENT UNION BUILDING AT CASE INSTITUTE OF TECHNOLOGY, UNIVERSITY CIRCLE, CLEVELAND, OHIO

Battery Division Round-Table Discussions

During the ninety-sixth meeting of The Electrochemical Society held last October in Chicago, the Battery Division sponsored two round-table discussions, one each in the fields of dry cells and storage batteries. After a short business meeting of the Division, the members divided into two groups, presided over by Dr. John N. Mrgudich and Dr. Eugene F. Willihnganz. The discussion was informal and consequently none of the material presented is available in published form. For this reason, brief summaries of the two sessions are given below.

Structure and Nomenclature of Manganese Dioxide

A brief talk by Mr. Birdsall of General Dry Batteries, Inc., emphasized the need for clarification of the nomenclature of manganese dioxide. Subsequent discussion pointed out that despite a significant amount of work carried out for the past several years, there still was no general agreement as to criteria characterizing the alpha, beta, delta, gamma, etc., phases reported by various workers and that lack of such agreement makes it difficult to specify desired structures in formal purchase specifications.

Dr. Kissin then read a paper, "Review of Current Status in Manganese Dioxide Research," prepared by Dr. Levin and Mr. Ney of Squier Signal Laboratory, Signal Corps Engineering Laboratories. On the basis of work done at SCEL and a critical review of the somewhat incomplete and conflicting literature, the authors recognize six distinguishable phase types of manganese dioxide: alpha, beta, ramsdellite, gamma, delta, and a new phase type designated as epsilon.

The *alpha* and *beta* phases, corresponding to the minerals cryptomelane and pyrolusite, have already been well characterized compositionally, structurally and morphologically, and there is no real disagreement on this characterization. *Ramsdellite* is considered a metastable phase or a pseudomorph but, being exceedingly rare, is not of particular importance to the dry cell industry at this time.

Gamma manganese dioxide, since there is substantial agreement that it has significant dry-cell depolarizing power, is a very important phase. After referring to some of the confusion relating to this phase, the authors cite their experience that the simplest x-ray diffraction pattern of the gamma phase, providing previous hydrous history has not been erased by thermal treatment, consists of spacings of 4, 2.4, 2.1, 1.6, and 1.4 angstrom units, together with a line at 1.06 Å if the background is not too dense. Thermal treatment destroys the 4 Å line. Slight variations in the above spacings are attributed to the nonequilibrium character of gamma manganese with the variations being related to individual sample history. The material is essentially hydrous in character, has an oxygen ratio in the vicinity of 1.95, is imperfectly crystallized and typically anhedral in morphological habit.

Delta manganese dioxide, a nonequilibrium, hydrous material of dense, anhedral subsequent habit, is characterized by a diffuse two-line pattern (2.4 and 1.4 Å).

Epsilon manganese dioxide, prepared by the oxidation of alkaline manganous solutions and whose particles have a thin flake-like habit, has a diffuse pattern in which the lines of the delta phase are accompanied by essential lines at 7 and 3.5 Å.

Dr. Fleischer of the U. S. Geological Survey, in a discussion of the Levin-Nye paper, indicated that the proposed designations were probably as acceptable as any that could be submitted at present.

A point was raised that, although a manganese ore showing the characteristic x-ray diffraction lines of gamma ore usually exhibited high dry cell activity, this is not invariably true. Dr. Kissin, for example, has shown that an electrolytic ore having the gamma pattern and, in addition, acceptable morphology, was still an inadequate depolarizer. Mr. Delano of E. J. Lavino and Company confirmed this, pointing out that he has synthesized several materials whose x-ray patterns corresponded to that of gamma yet whose depolarizing activity was disappointingly low. Mr. Mrgudich of Winchester Repeating Arms attempted an explanation of these apparently anamolous samples of gamma ore on the basis that although proper structure and morphology were necessary conditions, they may not be sufficient. He proposed that an additional property of an adequate depolarizer might involve residual electronic conductivity of the ultimate ore particles.

Another paper from SCEL was submitted by Mr. Clark and read by Mr. Cahoon of National Carbon Company but discussion of this was interrupted by adjournment for luncheon.

In the afternoon session Dr. Vinal of the Bureau of Standards presented data indicating that although electrolytic ores are the more active depolarizers at room temperatures, chemical ores can be used to greater advantage at low temperatures. Mr. Otten of E. J. Lavino and Company used this as confirmation of his opinion that chemical methods should be considered for synthesizing dry cell depolarizing manganese dioxide before accepting the high capital investments associated with adoption of electrolytic processes.

J. N. Mrgudich

Low Temperature Performance of Storage Batteries

The Storage Battery round-table discussion on "Low Temperature Performance of Storage Batteries," presided over by Dr. Eugene Willihnganz was attended by twenty-six members and guests.

It was opened by Mr. Sven Bergstrom, President of Nife Incorporated —manufacturers of nickel cadmium storage batteries—who disclaimed some of the sensational statements which had been made regarding these batteries in the "Reader's Digest" and in various Sunday-supplement articles. He said that nickel cadmium batteries had a definite place in the battery field, for various reasons including long life, inherent ruggedness, and "ready-to-serve" characteristics after stand-by periods of inactivity and neglect.

Their ability to work down to low temperatures has been proven, for example, in Sweden where batteries have been operating satisfactorily above the Arctic Circle on Swedish trains and buses, for the last 30 years. The majority of these batteries were mounted in positions exposed to weather and Arctic temperatures.

Mr. Bergstrom stated that, although laboratory tests have not been made of the performance of the "Nife" battery below −40°F, he felt that their successful operation may be possible. Mr. Bergstrom stated further that the re-

quirements for batteries able to work at −65°F may not be fulfilled by the nickel-cadmium batteries in their present construction, and it was agreed by those present that this also applied to all present commercial types of batteries.

In comparison with nickel-iron batteries, nickel-cadmium batteries show certain advantages, for instance their ability to accept low charge rates. They appear to be able to recuperate quickly from repeated quick high-load discharges.

Mr. Eidensohn of the Bureau of Ships, U. S. Navy, reported that in a direct comparison of a three-cell lead-acid battery to a five-cell Ni-Cd, 175 amp-hr capacity, discharged at 650 amp at 0°F, they got about four minutes to ½ minute respectively, the Ni-Cd failing due to poor voltage at this temperature and rate. Mr. Bergstrom then observed that if the test conditions had been known beforehand it might have been possible to choose batteries designed to meet the requirements.

The characteristics of lead-acid cells were next considered. Dr. Clark discussed his x-ray studies of the active materials at low temperatures. These studies indicated chiefly the nature of reactions and products, particle size, porosity, and strain in the crystal lattice. He said no new reactions or products seem to be involved as temperatures are lowered, although below −40°F some change does take place in the crystal pattern which may be involved in the sharp drop-off in capacity. He says lower temperature of charging (and cycling) favors the formation of true PbO_2 although this compound is always somewhat defective varying from PbO_2–$PbO_{1.67}$. Cycling at lower temperatures likewise decreases porosity, for example, cycling at −65°F loses 75 per cent of normal 80°F porosity. He feels that we have still much to gain by proper choice of conditions, oxides, and expanders. It was suggested by Mr. Rose that possibly ice formation at the active material—electrolyte interface—was the cause for almost complete loss of capacity below −40°F, and possibly for the difficulty of charging, and that our problem was to select a proper catalyst for our electrolyte rather than our active materials.

The meeting was cut short by lunch period and was resumed afterward with informal discussion lasting until 4:00 P.M. Members present voted the discussion a complete success.

C. C. Rose

NACE Advises on D-C Traction Power

Subcommittee TP12 of the Technical Practices Committee of the National Association of Corrosion Engineers met recently to discuss corrosion problems arising from positive polarity grounding of d-c supply equipment, and to make recommendations on the subject. The question arose because of a recent trend toward positive grounding of rectifiers supplying mine traction systems. It was widely believed that this practice would lead to a difficult electrolysis problem on underground structures in the vicinity of the mines.

During the discussion, it was noted that the standard practice of d-c street-railway and interurban systems has been to use a ground on the negative side of the supply at substations. While there may be other reasons for this practice, it was concluded that the controlling factor is the effect on electrolytic corrosion of the tracks and other metallic underground structures in their vicinity. Negative grounding minimizes electrolytic corrosion of metallic structures which are normally bonded to the negative bus. The structures of other utilities within the influence of track potential are in danger only within a small area near the supply point. Since the danger area is small, protection by bonding to the negative bus is usually economical.

If positive grounding at the supply point is used, these advantages are not only lost but may become serious disadvantages. Protection of nearby structures is much more difficult. In mine traction systems "portable" substations are used. These are provided with rectifiers having heat exchangers connected to the rectifier tanks for cooling. The rectifier tank is in the positive side of the circuit. For this type of service there are advantages to positive grounding, and many new installations are of this polarity.

It was agreed that a uniform grounding practice for mines is desirable. If neighboring mines are operated with traction systems oppositely grounded, under fault conditions, there is the possibility that almost double voltage could be applied across the insulators of the non-faulted system.

After considering all of the above factors at length the Committee unanimously approved the following three recommendations:

1. Negative grounding of d-c traction power supply equipment, including rectifiers, is preferable from the standpoint of the stray current electrolysis problem on underground structures in the mine and on other structures in the vicinity, such as pipe lines, cables and the like.
2. New installations of d-c power supply equipment should be grounded on the negative side.
3. Every consideration should be given to converting existing positive grounded systems to the negative ground arrangement.

Further information may be obtained from H. L. Hamilton, Chairman of Committee TP12 at 260 South Broad Street, Philadelphia 1, Pennsylvania.

Edward Weston Biography Announced

The McGraw-Hill Book Company has announced publication of "A Measure for Greatness" by David O. Woodbury. This is a biography of 230 pages covering the life of Edward Weston, a name familiar to many on electric instruments and standard cells, who generously provided funds for the Weston Fellowship of The Electrochemical Society. Members will welcome this readable biography of a man who contributed in large measure to electrochemistry and who was a good friend of The Electrochemical Society.

By special arrangement with the publisher, members of the Society may order the book at 15% discount. This makes the net price $3.40 plus postage, or, if cash accompanies the order, the postage may be omitted. Orders should be sent direct to Mr. Robert E. Ewing, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 18, N. Y., mentioning membership in The Electrochemical Society.

A review of the book appears in this issue of the Journal on page 77C.

Heart Butte Dam Finished Year Early

Heart Butte Dam, the second major dam of the Missouri River Basin Project to be completed by the Bureau of Reclamation, has been finished almost a year ahead of schedule, according to a recent announcement from the Secretary of the Interior.

The dam will create a storage reservoir with total capacity of 428,000 acre-feet which will be used for irrigation storage, flood control, and silt retention. Cost of the dam and reservoir was approximately $3,335,000.

DIVISION NEWS

Electronics Division

For several years, a committee headed by Dr. J. W. Marden has been engaged in revising the by-laws of the Electronics Division. The revision was necessary because of the broadened scope of the Division's activities and some changes in the constitution of the Society. The revised by-laws of the Division were submitted to the Board of Directors of the Society at their meeting on December 3, 1949, and were approved as submitted.

The Electronics Division has sponsored symposia and round tables on Luminescence and Fluorescence, Rare Metals, Electronic Instrumentation, and related subjects as well as General Electronics. Because of this diversity of interests within the Division, the new by-laws call for the election of several vice-chairmen, each of whom will represent one of the above subjects in the Division.

The annual business meeting of the Electronics Division will be held at the Spring Convention at Cleveland; details will be given as soon as the final arrangements are completed. At this meeting, the new by-laws will be presented to the membership for their approval; election of officers is also on the agenda.

Copies of these by-laws are being sent to all known members of the Electronics Division. However, with the rapidly expanding program of this Division, it has not been possible to keep up with all persons interested in the subjects outlined above. If you do not receive a copy of the by-laws and are interested in any phase of the fields of activity of the Electronics Division, please notify the secretary of the Division:

J. R. Musgrave
The Eagle-Picher Company
P. O. Box 290
Joplin, Missouri

Your name can then be added to the membership list of the Electronics Division.

The nominating committee consisting of Dr. J. W. Marden, Chairman, E. Gideon Widell, and Dr. Marlin E. Fogle have proposed the following nominations:

General Chairman — Erwin Lowry, Sylvania Electric Products, Inc.

Vice-Chairman for Fluorescent Group —Herman Froelich, General Electric Company

Vice-Chairman for Rare Metals Group —Bruce Gonser, Battelle Memorial Institute

Vice-Chairman for General Electronics Group—D. W. Wamsley, R.C.A. Manufacturing Co.

Secretary-Treasurer for Electronics Division—John R. Musgrave, Eagle-Picher Company.

The by-laws state: Article IV, Sections 2a and 2d—

"Additional nominations for offices may be made by petition signed by five (5) members of the Division which must be in the hands of the Chairman of the nominating committee before the election."

"Each nominee should be notified in advance of the responsibility of the office, and the nominating committee should receive his assurance of willingness to serve if elected."

John R. Musgrave
Secretary-Treasurer

SECTION NEWS

Chicago Section

The Chicago Section was treated to an interesting lecture on "Atomic Energy" by Dr. George H. Glockler, Department of Chemistry and Chemical Engineering, Iowa State University, at its January 6th meeting at the Chicago Engineers' Club.

Dr. Glockler's discussion of the theory of the development of power as heat from the fission of certain elements was both enlightening and enjoyable to the 40 members and guests present at the meeting. He prefaced his talk with the fact that the disappearance of a small amount of mass corresponds to a large amount of energy.

Dr. Glockler then went on to develop this idea in more concrete terms, in which he finally showed that the transformation of 1 gram of matter corresponded roughly to 2.15×10^{13} calories of heat. The speaker then indicated that it would take approximately 27 tons of TNT to liberate the same amount of energy as heat. Dr. Glockler discussed the concepts of atoms, protons, electrons, and neutrons, and their effect on the development of the theory of the structure of matter and the possibility of nuclear fission.

Throughout his lecture Dr. Glockler highlighted the technical information with humorous anecdotes which served to make this serious subject most enjoyable to the audience.

J. H. Conolly, *Secretary*

Cleveland Section

At its December 13th meeting, at the Cleveland Engineering Society, the Cleveland Section was brought up to date on developments and plans in connection with the Spring Convention, and on actions taken at the previous Board meeting in New York.

Following this, Mr. Morton S. Kircher of the Hooker Electrochemical Company, Niagara Falls, New York, addressed the members and guests on the subject "The Electrolytic Chlor-Alkali Industry." The speaker pointed out that this industry is now second only to aluminum as the largest consumer of power of the electrochemical industries in the United States. An outline was given of its growth and of its standing in relation to the industry abroad.

Morton S. Kircher

The talk was illustrated with many slides taken both here and in Europe. At the speaker's request, the talk was frequently interrupted for floor discussions. A summary of the principal data presented follows:

The United States production capacity for chlorine has increased to an estimated 5500 tons per day in 1950. The chlor-alkali industry is second only to aluminum as the largest electrochemical user of power. The rapid expansion in uses of chlorine is tending once again to make chlorine the most sought after "member of the chlorine-caustic team."

In reviewing the fundamental principles of diaphragm and mercury cells, it was pointed out that although the current efficiencies of both type cells are normally in the range of 94–96 per cent, the processes causing current efficiency loss are different in each case.

In the diaphragm cell migration of hydroxyl ion through the diaphragm causes the principal loss; whereas in the mercury cell, chlorine attack on the amalgam causes the principal loss.

Technical factors which are of importance in determining the optimum size cell are: (*a*) basic cell design, (*b*) voltage - efficiency characteristics of power conversion equipment, and (*c*) size of plant required.

Early cells of circular or single plane design were limited to capacities of about 1000 amperes, whereas newer types such as multianode-deposited diaphragm cells and disk-type vertical mercury cells may be expanded to 30,000 amperes or higher.

The high efficiency obtainable at high voltages such as 600–700 volts with mercury arc rectifiers has had a tendency to favor moderate sized cells such as 7000–10,000 amperes, except for large plants of 100 tons per day capacity or larger, since a great number of cells are required in series to give an economically high voltage. The erection of plants of 200–300 tons per day capacity or larger has given impetus to the use of larger cells such as 20,000 amperes. The recent development of contact rectifiers which give high (95–97 per cent) efficiencies at voltages in the range of 200–400 should also tend to encourage the use of larger cells even for small plants.

It is predicted that future developments will include a gradual swing toward larger capacity cell units, further development of vertical mercury cells, use of cells operating under moderate or high pressure, and development of processes for production of chlorine other than electrolytic.

* * *

At the Section's meeting on January 10th, Mr. Clarence C. Rose of the Willard Storage Battery Company, Cleveland, Ohio, gave a very informative talk on "Some of the Lesser Known Characteristics of Lead Acid Storage Batteries." Mr. Rose is Chairman of the Battery Division of The Electrochemical Society and has had wide experience in this field. A summary of his discussion follows:

In the face of a serious depletion of our lead supply, we continue to expand our use of lead acid storage batteries. These range in size from less than 0.1 amp-hr in radiosonde balloon batteries to 10,000 amp-hr of telephone and submarine cells. By far the largest number of batteries produced are the automotive type of which we now manufacture in this country about 25,000,000 per year for the 40,000,000 vehicles in use.

Battery design has apparently kept pace with increased requirements in the form of higher electrical loads and high charging rates. For example, at 300 amp at 0°F which is selected as an average starter load, capacity has been increased from 2.5 minutes not so many years ago to 3.5 to 4.0 minutes on a 100 amp-hr battery, with 5.0–6.0 minutes available if necessary. Ultimate battery service life is generally dependent upon many other factors, the chief of which is the accuracy of charge control by automatic voltage regulation.

This is a particularly difficult problem because of:

(*a*) Wide range of driving habits—continuous vs. intermittent use.
(*b*) Wide range of full charge battery voltage depending upon battery temperature and charge rates.
(*c*) Neglect in adding water to maintain correct acid levels.
(*d*) Faulty regulator operation which may destroy a battery from either overcharge or undercharge.

Batteries are designed to operate under overcharge conditions, and ultimate life depends upon the rate and time of overcharge. Overcharge failure is indicated by the destruction of positive grids and cycling failure is generally indicated in the loss of positive active material.

Batteries cannot stand extended periods of undercharge without premature failure. Undercharge or high acid gravity due to neglect in maintaining acid level is generally indicated in negative plate failure due to sulfation. Most automotive battery failures are due to these causes. Service life, therefore, may be prolonged by watching voltage regulator adjustment to maintain full charge gravity 1.285 without the need of excessive water makeup to maintain electrolyte level.

Contrary to some popular opinions, batteries are not harmed by high discharge rates provided they are promptly and properly recharged. Likewise, they can accept high recharge rates under proper control of voltage and temperature. The ampere hour law states that a battery is able to accept a charge rate in amperes numerically equal to the number of ampere hours then out of the battery. Fast chargers are designed to operate on this principle with proper voltage and temperature controls to prevent gassing and overheating.

Cold weather starting is the most critical service a battery has to perform with all factors adversely affecting actual capacity. As temperature drops, the actual load of turning over the motor increases, capacity drops normally due to temperature drop alone, still further by a large factor due to the increase in discharge rate. Thus what we thought was 100 amp-hr available at 80°F becomes 15 amp-hr or less as temperature drops to zero or below. If the situation is further handicapped by a battery in various stages of discharge and nearing the end of its life expectancy, you may not start at all.

The lead acid battery is outstanding in its ability to perform under these conditions of low temperature and high rates. Demands have been increased with temperatures being dropped to −40°F and finally −65°F. This latter condition has not yet been met satisfactorily and it is doubly handicapped by the fact that it is practically impossible to recharge batteries at these temperatures.

In spite of some publicity to the contrary, there are no other kinds of storage batteries available for automotive service at the price, within weight and size equivalents, and able to serve under conditions imposed and temperatures encountered in this country.

H. C. Froelich, *Secretary*

Detroit Section

The Detroit Section of The Electrochemical Society and the Detroit Branch of the American Electroplaters' Society held a joint meeting on January 6th at the Statler Hotel. Dr. Louis Weisberg, Consulting Chemical Engineer, New York City, was introduced by Mr. Bernard Case, and addressed the joint assembly on the subject of "Polarization and Other Phenomena."

Dr. Weisberg limited his discussion of this broad subject to an explanation of the connection between hydrogen overvoltage and the nature of the electrode on which the hydrogen is being evolved.

The speaker first discussed the present idea of the structures of metal as face centered cubes. Dr. Weisberg pointed out that the rate determining steps in evolution of hydrogen at the electrode are the neutralization of hydrogen ions to form atomic hydrogen and the combination of hydrogen atoms to form hydrogen molecules.

Dr. Weisberg discussed the nature of metals and the relationships between metals from the standpoint of periodic functions and the quantum theory.

In his closing remarks the speaker directed attention to the fact that there is a vast fund of physical-chemical information now available which should be of great value to the electrochemist.

M. L. Baty, *Secretary-Treasurer*

Midland Section

The Midland Section of The Electrochemical Society held its second meeting of the 1949–50 season in the Dow Auditorium in Midland on January 17, 1950. Guest speaker for the occasion was Mr. Don M. McCutcheon of the Ford Motor Company who presented a very interesting talk on radioactive isotopes and their application to industry. Mr. McCutcheon was accompanied by Mr. Homer Myers, Vice-President of Radio-Active Products Incorporated.

Mr. McCutcheon's talk touched upon a variety of different aspects of the industrial uses of radio-isotopes. In introducing the subject, he emphasized the need for the proper psychological preparation of plant and laboratory personnel prior to the carrying out of actual experimental work. Such preparation is needed to allay the fears engendered by the barrage of newspaper publicity laid down over the past several years. The different types of radiation available from the various radioactive sources were described and compared from the standpoint of applications and general usefulness. Beta and gamma emitters have been found to be most useful in industrial work although some fruitful applications for alpha emitters, such as the measurement of gas flow rates, are now appearing. The use of radioactive cobalt in industrial radiography was discussed and a comparison was made of the economics of radio-cobalt vs. radium for this application, the former being much the cheaper. Radiography with high voltage x-rays vs. radio-cobalt was also compared, the latter comparing quite favorably. Various other applications for radio-isotopes, ranging from the gaging of molten metal levels in foundry cupolas, to the continuous direct measurement of oil consumption in automobile engines, were discussed.

At the conclusion of Mr. McCutcheon's talk, Mr. Myers presented an interesting demonstration of the various types of equipment used to measure radiation and illustrated the properties of different types of radiation with "on-the-spot measurements."

H. A. Robinson, *Secretary-Treasurer*

New York Metropolitan Section

"Words at Work" was the subject of an address given by Mr. Fred P. Peters of the Reinhold Publishing Company, New York, to the members and guests of the New York Metropolitan Section at its January 25th meeting. The Section met at the Holley Hotel for dinner, preceded by a social period and followed by the technical meeting at 8 P.M.

Mr. Peters' talk on "Words" was anticipated with keen interest as technical men are well aware of the importance of good writing and speaking in their daily work. Mr. Peters discussed the more common flaws of technical writing and suggested means for using words more effectively. The speaker seasoned his talk with humor, adding to the pleasure and interest of the subject.

Mr. Peters own experience includes that of managing editor and then editor-in-chief of "Metals and Alloys" and he is currently Vice-President and Secretary of Reinhold and manager of the Book Division. A short synopsis of his talk follows:

The need for technical men who are able to write well is a challenge to engineers and educators. It is also a personal opportunity for us as individuals.

The basic principles of good writing for any purpose are: (1) write for your reader, (2) be natural, (3) be clear, and (4) be brief. And the greatest of these is clarity:

We technical men should avoid the use of highly technical terminology in most of our writing. We can develop naturalness also, by adopting a simple style free from stiff constructions and floweriness. Clarity is the result of logical arrangement, the use of short sentences, the use of short words, the use of the right words, and the use of words in the right places. Brevity can be achieved, in most cases, by sticking to the essentials of the subject and by eliminating the hundreds of unnecessary words with which we clutter our writing.

Engineers can easily apply these principles to their most important writing tasks—letters, magazine articles, reports, and scientific papers. The chief need in letter writing is a friendly, natural tone. In magazine articles, emphasis is on remembering the reader and on clarity. For technical reports and scientific papers clarity and brevity should dominate, but in addition report writers have a special obligation to keep their readers always in mind.

Much reading of classical writers with a terse style can be a big help to engineers in improving their own writing. For the biggest practical improvement will come with shorter sentences and shorter words, as advocated by Rudolf Flesch.

● The editors hope to publish, in the near future, a feature article based on Mr. Peters' talk.

Philadelphia Section

The second meeting for the current season of the Philadelphia Section of The Electrochemical Society was held on January 11, 1950, in the Harrison Laboratory, University of Pennsylvania. A dinner at the Lenape Club in honor of the speaker, Mr. Felix B. Litton of Foote Mineral Company, preceded the meeting. Thirty-one members and guests attended the dinner and about 50 attended the technical meeting.

Mr. Litton who is Chief Metallurgist in the Research Development Department, Foote Mineral Company, chose as his topic "The Present Status of Titanium." His experience in metallurgy has been extensive and varied, having been connected with the Tennessee Coal, Iron and Railroad Company of Alabama, Battelle Memorial Institute, Bendix Aviation Corporation, and the Foote Company. He is one of the inventors of the iodide process for zirconium and titanium. Pertinent excerpts from his address appear in the "Feature Section" of this issue.

J. F. Hazel, *Secretary*

San Francisco Section

The January meeting of the San Francisco Section was held at the St. Julien Restaurant in San Francisco on January 18, 1950.

Among the various items of business taken up was the appointment of a Nominating Committee. The members serving on this committee are W. H. Hammond, Chairman, J. F. Aicher, and C. W. Tobias.

The guest speaker for the evening was Mr. R. T. Effinger of the Shell Oil Company, Martinez, California. His subject was "Corrosion of Refinery Process Equipment."

The talk was well illustrated by a series of slides of various pieces of equipment which had failed because of different types of corrosion. Mr. Effinger discussed the case illustrated by each particular slide, explaining the history of the equipment, the type of corrosion which occurred, and the mitigative

measures used to correct the condition. In some cases, the cause of the corrosion was removed by changes in operating procedure or addition of reagents which would neutralize the corrosive material. In other cases, a different material of construction able to withstand the particular corrosive atmosphere was substituted for the material used in the original installation. In still other cases, such as where stress corrosion occurs, the material of construction is satisfactory, except that a special treatment for stress relieving the material is necessary. Another interesting example concerned the establishment of a potential due to dissimilar metals being placed in contact with each other. This often occurs when a welding electrode of improper composition is used with the result that a potential is set up between the weld metal and the regular material of construction and one of the materials is subjected to electrolytic corrosion.

One obtained the impression, while listening to Mr. Effinger's talk, that the 55 million dollar annual corrosion bill in the United States cannot be eliminated by one or two standard procedures. Each particular corrosion problem can be solved only after a complete study of the plant process, its operation, and the equipment used are considered.

The talk was extremely well received by all members and guests in attendance. A lively question and answer period followed.

R. F. Bechtold, *Secretary-Treasurer*

Washington-Baltimore Section

The Washington-Baltimore Section held its regular meeting on January 19, 1950, at the Bureau of Standards and had as its guests the local section of the American Electroplaters' Society. The large attendance, in spite of inclement weather, was gratifying to the new Section.

Dr. Leon F. Curtiss, Chief of the Neutron Measurement Section of the Atomic and Molecular Physics Division at the National Bureau of Standards, was the guest speaker of the evening and gave an excellent discussion of the subject "Radioactivity and some of its Applications." Dr. Curtiss outlined the procedures for obtaining radioactive isotopes by bombarding the atom with electrons, deuterons, or neutrons in a reactor or cyclotron. The neutron, with its neutral charge, is the most effective since it is able to penetrate the nucleus of the atom much easier than a charged particle. The speaker pointed out that the methods of measuring radioactive isotopes present some problems primarily due to establishment of new standard units of measuring quantity and intensity. This is because of the different nature of the various radiations emitted. A number of instruments for measuring these quantities have been made such as the Geiger counter, electroscope, and various dosage meters.

The application of radioactive isotope techniques are considered useful in studying problems which are not readily solved by conventional means.

Leon F. Curtiss

For example, in the following reaction it is practically impossible to prove whether the I_2 comes from the KIO_4 or the KI by any conventional method:

$$KIO_4 + 2KI + H_2O \rightarrow KIO_3 + I_2 + 2KOH$$

However, if the KI is prepared from a radioactive isotope of iodine it is then possible to determine whether the I_2 is radioactive or not. In this case it has been found that all the I_2 comes from the KI.

There are a number of applications already being explored for use of radioactive isotopes in the research field. One of these is in the electroplating field where composition and variation in thickness of plating may readily be determined.

At the conclusion of Dr. Curtiss' discussion Mr. F. Ogburn and Dr. Abner Brenner gave a demonstration of the various instruments used in measuring radioactivity, and electroplated several sample plates with the cobalt radioactive isotope.

Following the lecture and demonstration, a business meeting was held. The Chairman, Paul L. Howard, announced that the Board of Directors had acted favorably on the Section's invitation to meet in Washington during the spring of 1951 while the National Bureau of Standards was holding its semi-centennial celebration. This meeting will be held April 8–11, 1951, at the Wardman Park Hotel. The steering committee, Mr. J. P. Marble, Chairman, Paul L. Howard, and Dr. Abner Brenner have appointed the following chairmen of the various committees for arrangements:

Hotel—Leo Waldron
Registration—I. A. Denison
Finance—R. S. Dean
Entertainment—W. J. Hamer
Transportation—R. B. Goodrich
Equipment—A. C. Hellfritzsch
Publicity—Samuel Eidensohn

The Nominating Committee (Dr. H. D. Holler, Chairman, Mr. Kenneth Huston, Mr. N. Promisel) reported that they nominated the present officers, listed below, for next year:

Chairman—Paul L. Howard
Vice-Chairman—Abner Brenner
Secretary-Treasurer—J. C. White, 4205 Woodberry St., University Park, Hyattsville, Md.

Paul L. Howard, *Chairman*

MEETINGS OF OTHER ORGANIZATIONS

National Electrical Manufacturers Association, Edgewater Beach Hotel, Chicago, Illinois, March 13–16

Greater New York Safety Council, 20th annual safety convention and exposition, Hotels Statler and Governor Clinton, New York City, March 28–31

A. G. A. Distribution, Motor Vehicle, and Corrosion Conference, Book Cadillac Hotel, Detroit, Michigan, April 3–5

E. E. I., 16th annual sales conference, Edgewater Beach Hotel, Chicago, Illinois, April 4–6

The American Society of Mechanical Engineers, spring meeting, Hotel Statler, Washington, D. C., April 12–14

The American Society of Refrigerating Engineers, semi-annual meeting, Muehlbach Hotel, Kansas City, Missouri, June 4–7

Edison Electric Institute, 18th annual convention, Auditorium, Atlantic City, New Jersey, June 6–8

BOOK REVIEW

A Measure for Greatness—A Short Biography of Edward Weston by David O. Woodbury. Published by McGraw-Hill Book Company, Inc., New York, 1949. 230 pages, $4.00.

This is a fascinating and readable account of the life of Edward Weston. The venerable Emeritus Professor of Electrical Engineering of Massachusetts Institute of Technology, Dugald C. Jackson, in a foreword to the biography says of Weston: "His name belongs with the group of the few great men who led the galaxy of distinguished electrical engineers of the United States and Europe and who laid by their inventions the foundations of what is now our great and useful structure of electrical engineering and electrical engineering industries. His biography will provide an inspiring stimulation to the thinking of today's electrical engineers."

The book is more than the story of the life of Edward Weston for it is indeed a history of the development of electrical engineering and electrical instruments. It is of special interest to electrochemists for Edward Weston, migrating to this country from England at the age of twenty, joined an electroplating concern then on the verge of failure and soon made significant contributions to nickel plating. This was in the early 1870's when nickel plating had become a fad. Unfortunately the platers had little idea of the importance of chemically controlled solutions, proper cleaning of parts to be plated, and other conditions necessary for successful plating. Weston's first invention and patent was on a new nickel anode. Soon after putting his first employer on his feet and handling his largest job, that of nickel plating New York City's new fire engines, he resigned to establish his own business and opened up a photograph gallery.

It was not long, however, until he was back in electroplating, a partner in the firm of Harris and Weston whose claim "we guarantee our nickel not to strip or peel" was well established and attracted sufficient business to enable the firm to weather the panic of 1873. Weston became dissatisfied with the use of batteries as a source of power for electroplating and, after considerable experimentation, constructed the first dynamo for electroplating. As his dynamos became generally used in the plating industry, Weston became well launched in the field of electrical machinery. During this time, he also did pioneer work in the electrorefining of metals, notably copper, silver, and gold.

The Weston Dynamo Electric Machine Company was organized in 1877 with Abraham Van Winkle, prominent in the field of platers' supplies, as president and Weston as general manager. At about this time, Weston became interested in lighting and invented a carbon arc light. His first arc light was installed in Newark in 1878 and caused a sensation. Weston's firm had now become the Weston Electric Light Company which was later absorbed by the United States Electric Lighting Company. The first contract for this firm was for lighting the new Brooklyn Bridge with two rows of Weston's arc lights on ornamental poles, using a Weston dynamo to run them. This company and the Weston lamp patents eventually passed to the Westinghouse Company, Weston himself becoming interested in experimentation on incandescent lamps as early as 1877. His first incandescent lamp invented in 1882 had a life of 2000 hours and was superior to Edison's lamp of the same period. By 1886, Weston had been granted 186 patents and it was about this time that the famous patent suits were filed by Edison against every one else in the lighting field.

Weston then retired from the electric lighting field and started a laboratory in the back of his Newark home for experimentation in the field of electrical measurement, then in a deplorable state. Thus, the field of Weston's greatest achievement was well launched with the establishment of the Weston Electrical Instrument Company in 1888. A steady succession of electrical measuring instruments, voltmeters, ammeters, a-c voltmeters, established the firm as the world leader in this field. Weston's saturated cadmium cell eventually became the world's standard of electromotive force. Weston waived his patents on this cell in order that it might be widely manufactured.

In later years, Weston became interested in civic affairs, although he avoided politics. He was one of the founders of the Newark College of Engineering. Honorary degrees from McGill, Stevens, and Princeton were conferred upon him. Becoming chairman of the Board of his company in 1924, Weston had more time for other activities. He died in 1936.

Edward Weston was a charter member of The Electrochemical Society and in 1928 established the Edward Weston Fellowship Fund. Mr. Woodbury's interesting account of Weston's life should be of great interest to electrochemists.

R. M. Burns

ANNOUNCEMENTS FROM THE PUBLISHERS

Corrosie by Dr. Ir. Van Der Veen. Published by Ultgeverij Waltman, Delft, Holland, 1949. 368 pages (in Dutch).

The author of this book is a consulting engineer and presents a survey of the field of corrosion, treating it mainly from the practical standpoint. In the nine chapters constituting his book, he covers the following subjects:

I. Corrosion in the Absence of Water; II. Corrosion in the Presence of Water—Electrochemical Theory; III. Corrosion by Stray Currents; IV. Corrosion in the Atmosphere; V. Corrosion in Waters (Natural & Artificial); VI. Corrosion in Soils; VII. Corrosion Testing; VIII. Surface Treatments; IX. Metallic Deposits; X. Paints; XI. Bituminous Products.

The book contains 35 figures and photographs, and 27 graphs, and includes a number of references to the literature.

Patent Law, 2nd edition, by Chester H. Biesterfeld. Published by John Wiley & Sons, Inc., New York, 1949. 267 pages, $4.00.

A practical guide for engineers, chemists, lawyers, and students. This book encompasses changes that have been made in patent law during the past five years, plus numerous significant court decisions of those years. Every important feature of the law relating to patents is treated in detail. Clearly written definitions, illustrative case histories and references make this a valuable handbook.

Electronics Manual for Radio Engineers edited by Vin Zeluff and John Markus. Published by McGraw-Hill Book Co., Inc., New York, 1949. 879 pages, $9.50.

Practical radio engineering data for radio and communication engineers; technical information on the design, production and use of electronic equipment. Includes circuit diagrams, charts, graphs, equations, and operating techniques. Some of the Section heads: Components, Microwave, Receivers, Antennas, Audio, Television.

LETTER TO THE EDITOR

Dear Sir:

The letter of my good friend Dr. W. C. Moore, on page 70C of the November issue of the JOURNAL, prompts me to report briefly the results of a few experiments intended to test the suggestion he makes. These experiments resulted from a conversation with Dr. Moore a couple of years ago.

The street car system here in Tuscaloosa was abandoned some years ago, and I am not at all sure that the samples of copper wire supposed to represent the two ends actually did so. Anyway they showed no appreciable difference in isotopic composition.

Experiments were then undertaken in the laboratory on silver wire, and iron wire, by running a direct current through them for various lengths of time and determining the atomic weight of the metal in the two ends, and in the middle. Despite some interesting figures in the early stages, no definite change in the isotopic composition could be established. However, as so often happens, this investigation led to a study of the "electrolytic" conductivity of alloys, which may be more fruitful.

STEWART J. LLOYD
University, Alabama

PERSONALS

W. L. HADEN, Jr., recently joined the staff of the Attapulgus Clay Company as a research chemist at their Camden, New Jersey, laboratory. Mr. Haden was formerly with the Pittsburgh Plate Glass Company in Barberton, Ohio.

W. J. COTTON announces the relocation of his consulting laboratories from Butler, Pennsylvania, to 3530 West Fairmount Avenue, Milwaukee, Wisconsin

WILLIAM CABLER MOORE, a Past President of the Society, was the guest speaker, on January 7th, at the regular Saturday morning broadcast sponsored by the Western Connecticut Section of the American Chemical Society over Station WICC, Bridgeport. Dr. Moore's topic was "Corrosion—an Enemy of the Pocketbook."

SAMUEL COTTRELL has taken a position as assistant to Dr. Carl F. Prutton, Vice-President and Director of Operations for Mathieson Chemical Corporation, with headquarters in Baltimore, Maryland. Mr. Cottrell was previously Vice-President of American Potash & Chemical Corporation, Los Angeles.

Dr. Southard on Aircraft Committee

Dr. John C. Southard, Electrochemical Society member who is Director of Research for Solar Aircraft Company, San Diego, California, has been appointed a member of the subcommittee on Aircraft Structural Materials, a technical subcommittee of the National Advisory Committee for Aeronautics. Before joining Solar in 1946 as manager

JOHN C. SOUTHARD

of the Factory Laboratory, he served with the U.S. Department of Agriculture, with the U.S. Bureau of Mines, and as Chief of Process Metallurgy Research with the Titanium Alloy Manufacturing Company. Dr. Southard holds a Ph.D degree in Physical Chemistry from Johns Hopkins University.

Wilson Directs Mines Bureau in Southwest

The appointment of Hewitt Wilson as regional director of the Bureau of Mines' Region VII, the Southeast, was announced recently by James Boyd, Bureau Director. At the same time the transfer of regional headquarters from Tuscaloosa, Alabama, to Norris, Tennessee was announced.

Mr. Wilson has been associated with the Bureau of Mines as technologist and administrator since 1920. He will be in charge of all Bureau activities in his region which includes the states of Tennessee, North and South Carolina, Georgia, Alabama, Mississippi, and Florida.

New Officers at Oldbury Electro-Chemical

The Oldbury Electro-Chemical Company of Niagara Falls, New York, announces the resignation of Mr. Walter Wallace as President and Treasurer of the Company as of December 31, 1949.

The new officers of the company are:

Dr. Earl L. Whitford—President and Treasurer
Dr. Marion B. Geiger—Vice-President and Assistant Treasurer
Dr. C. A. Steigman—Secretary
Mr. Maynard L. Parker—Assistant Secretary
Mr. Harold L. Townend—Assistant Secretary

Mr. Wallace had been with Oldbury Electro-Chemical Company since 1902. He succeeded Mr. Lidbury as president in 1947 continuing until his retirement in December, 1949. He is a long-time member of The Electrochemical Society having joined in 1909.

Dr. Whitford, the new head of Oldbury, was executive vice-president of the company for the past three years. He originally joined the company in 1925 coming from the Chemistry Department of the University of Wisconsin. During his first ten years at Oldbury, his work was in the research and development division, as assistant works manager, and for about eleven years following that he was general sales manager of the company. His technical interests are largely in the fields of inorganic and physical chemistry. He has been a member of The Electrochemical Society since 1936.

March 15 Deadline for Engineering Survey

The closing date for the nation-wide survey of selected engineering personnel has been announced as March 15, 1950. The survey is being sponsored by the Engineers Joint Council for the U. S. Office of Naval Research and to date over 60 per cent of the questionnaires sent to full members of 18 national engineering societies, including The Electrochemical Society, have been answered.

The body of facts gathered by the survey will be available to Government agencies, private, industrial, educational, and professional society planning groups. Those who have received the questionnaire and have not yet answered it are urged to do so before the March 15th deadline.

NEW MEMBERS

At the meeting of the Executive Committee held on January 12, 1950, at the office of The Electrochemical Society, Inc., 235 West 102nd Street, New York City, the following were elected to membership:

Active Members

DAVID A. AITKEN, mailing add: The Cleveland Electric Illuminating Co., 75 Public Square, Cleveland, Ohio (Industrial Electrolytic)

GEORGE C. ALLEN, Mathieson Chemical Corp., mailing add: 806 Ashland Avenue, Niagara Falls, New York (Alkali and Chlorine, and Electrodeposition)

FRANCIS N. ALQUIST, The Dow Chemical Company, mailing add: 2416 Manor Drive, Midland, Michigan (Corrosion)

ARTHUR H. ANDERSEN, Shawinigan Chemicals Ltd., Shawinigan Falls, P.Q., Canada (Battery, Electro-Organic, Electrothermic, and Industrial Electrolytic)

ARNOLD ARCH, ISCO Chemical Division, mailing add: 910 Vanderbilt Avenue, Niagara Falls, New York (Industrial Electrolytic)

NORMAN BAUER, Physical Science Associates, mailing add: 1 Arlington Avenue, Berkeley 8, California (Theoretical Electrochemistry)

JEANNE B. BURBANK, Naval Research Laboratory, mailing add: 3304 Cleveland Avenue, N.W., Washington 8, D. C. (Battery)

WILLIAM H. BYLER, U. S. Radium Corp., mailing add: 43 E. Hanover Avenue, Morris Plains, New Jersey (Electronics)

WALTER C. COOPER, mailing add: Dept. of Chemistry, University of Wisconsin, Madison, Wisconsin (Electrodeposition, Electro-Organic, and Theoretical Electrochemistry)

PAUL DELAHAY, mailing add: Louisiana State University, Department of Chemistry, Baton Rouge 3, Louisiana (Corrosion and Theoretical Electrochemistry)

JOHN E. HAWKINS, mailing add: Department of Chemistry, University of Florida, Gainesville, Florida (Theoretical Electrochemistry)

EDWARD G. HOLLMAN, mailing add: Eagle Picher Co., Joplin, Missouri (Battery and Electrodeposition)

JOHN C. LEWIS, JR., Driver-Harris Co., mailing add: 45 Ridgewood Terrace, Maplewood, New Jersey (Electronics, Electrothermic, and Theoretical Electrochemistry)

JOHN K. MADDOCK, John Wiley & Sons, Inc., mailing add: 440 4th Avenue, New York, N. Y.

VICTOR G. M[illegible]KOW, Ste de Chimie Ind., mailing add: Serrano 7, Madrid, Spain (Electro-Organic and Industrial Electrolytic)

JOSEPH MONSELISE, Assis Ltd., mailing add: Rechov Hagilboa 18, Tel-Aviv, Israel (Corrosion, Electrodeposition, Electronics, Electro-Organic, and Industrial Electrolytic)

FIELDING OGBURN, National Bureau of Standards, mailing add: 9607 Riley Place, Silver Spring, Maryland (Electrodeposition)

GUSTAV SZEKELY, mailing add: Sylvania Electric Products, Inc., 35-22 Linden Place, Flushing, Long Island, N. Y. (Electrodeposition, Electro-Organic, and Theoretical Electrochemistry)

D. H. WAMSLEY, mailing add: R.C.A., Victor Division, New Holland Avenue, Lancaster, Pennsylvania (Electronics)

ROGER J. WELLARD, mailing add: 22 Guai Gallieur, Suresnes, Seine, France (Corrosion and Electrodeposition)

JASPER WOLKOFF, Armour Research Foundation, mailing add: 7256 Dorchester Avenue, Chicago 19, Illinois (Electronics, Electrothermic, Industrial Electrolytic and Theoretical Electrochemistry)

Reinstatement

HARRY B. OSBORN, JR., mailing add: Ohio Crankshaft Company, 3800 Harvard Avenue, Cleveland 1, Ohio (Electrothermic)

Associate Member

DODD S. CARR, mailing add: International Nickel Co., Inc., Research Laboratory, Bayonne, New Jersey (Electrodeposition)

Student Associate Member

EDWARD B. SAUBESTRE, Columbia University, mailing add: 80-15 57th Avenue, Elmhurst, Long Island, New York (Electrodeposition)

PHYSICAL SCIENCE ASSOCIATES
DIRECTORS: G. H. KISSIN AND NORMAN BAUER
CONSULTATION, RESEARCH AND DEVELOPMENT
ELECTROCHEMICAL AND METALLURGICAL PROCESSES
PHYSICAL METHODS OF ANALYSIS
X-RAY DIFFRACTION AND MASS SPECTROMETRIC ANALYSIS
P. O. BOX 515 BERKELEY, CALIF.

RECENT PATENTS

Selected for electrochemists by Fred W. Dodson, Chairman of the Patent Committee, from the Official Gazette.

November 8, 1949

Sharp, F. H., and March, C. C., 2,487,076, Process for Producing Alumina

Byler, W. H., 2,487,097, X-Ray Screen

Hoover, G. R., and Cox, N., 2,487,137, Producing Coatings on Metal

Berr, C. E., 2,487,214, Fused Pyrosulfate-Halide Solvent Electrolyte

Thurber, A. E., 2,487,399, Electroplating Apparatus

Webb, E. F., 2,487,499, Spirally Wound Storage Cell

Dahm, T. M., and George, M. F., Jr., 2,487,526, Electric Fire Detector

Lepsoe, R., 2,487,770, Electric Furnace

November 15, 1949

Rupp, J. L., 2,487,831, Storage Battery with Concentric Cells

Adams, M. A., 2,487,917, Battery Clamp

Ruben, S., 2,487,985, Thermoplastic Conductive Joint for Flat Cells

Stareck, J. E., and Passalacqua, F., 2,438,246, Process of Electroplating Zinc, and Baths and Compositions for Use therein

Williams, H. A., 2,488,360, Battery Casing

Madorsky, S. L., 2,488,474, Preparation of Anhydrous Magnesium Chloride and Recovery of Metallic Magnesium

November 22, 1949

Striplin, M. M., Jr., and Kelly, W. M., 2,488,568, Production of Aluminum-Silicon Alloys

Wood, L. E., 2,488,573, Evacuation Pump and Filler Assembly for Filling Batteries

EMPLOYMENT SITUATION

Please address reply to box shown, % The Electrochemical Society, Inc., 235 West 102nd Street, New York, N. Y.

Position Wanted

Electrochemist with 14 years' experience in electroplating and electroforming desires position with good future. Last six years has had supervision of research and development in precision electroforming field. Age 32 years. *Reply to Box 336.*

NOTES FROM INDUSTRY

Personalities

General Electric Company's apparatus department has named seven of its executives to new positions in its Large Apparatus Divisions. Changes are as follows: C. W. Fuller, transferred to the staff of the Manager of Manufacturing; N. E. Firestone, appointed Staff Assistant to the Manager of Manufacturing; K. O. Schulte, appointed Manager of Wage Rate; W. H. Bobear, appointed Manager of Purchasing; T. F. Garahan, appointed Production Manager; K. N. Bush, appointed Assistant Production Manager; A. V. Feigenbaum, appointed Supervisor of Training, Manufacturing Personnel.

Charles E. Crowley was recently elected president of the Alsop Engineering Corporation of Milldale, Connecticut. He succeeds the late Samuel Alsop, Sr., as head of the concern. The other officers of the company are Samuel Alsop, Jr., first vice-president; W. W. Freystedt of New York City, second vice-president; James J. O'Shea, third vice-president, E. Z. Ross, secretary and treasurer; and C. Clark Morganson, assistant secretary.

Monsanto Chemical Company has announced the appointment of Charles B. Durgin as associate director and Henry V. Moss, Edgar E. Hardy, and Christian H. Aall as assistant directors. The appointments became effective January 16th.

Tolman G. Everett has been elected as secretary and comptroller of Victor Chemical Works. Mr. Everett has been secretary of the company since 1946 and succeeds Mr. Webster in the comptrollership, the latter having become a member of the new governing committee of the company.

The American Platinum Works of Newark, New Jersey, has recently opened a new midwest sales and service office at 55 East Washington Street, Chicago, Illinois. Mr. Herschel R. Cole is the company representative there. Local inquiries for silver anodes, silver cyanide, and silver brazing alloys are welcomed.

Products

A. Daigger & Company of Chicago has available a new pH paper, oxyPhen, made in Switzerland, using carefully tested and buffered solutions and dyes, thus introducing a new idea into the field of hydrogen ion determination. A real improvement over existing pH papers, no color comparison charts are necessary. Each strip of oxyPhen paper comes with its own color chart and the pH is read directly from the strip. Using oxyPhen, anyone can run a pH determination in a few seconds. Additional information about this new pH paper may be obtained by writing to A. Daigger & Co., 159 West Kinzie Street, Chicago 10, Illinois.

The Consolidated Mining and Smelting Company of Canada Limited is now producing indium, one of the rare metals. The newcomer to the long list of metals produced by the company is now available in commercial quantities. Because of the large-scale operations at Tadanac, it has been possible to recover and refine indium from the minute quantities present in the ore of the Sullivan mine. All metal produced will be 99.99 per cent minimum purity. To be marketed under the well-known "Tadanac" brand, the company's indium will be steadily available in any reasonable quantities for commercial users.

Rotofilm, a new transfer film that is revolutionary for use in making cylinders and plates in the gravure printing process, has been developed by E. I. du Pont de Nemours & Co., Inc. Composed of a cellulose acetate safety base with a stripping membrane upon which is coated a photographic emulsion, Rotofilm requires no advance preparation and exposures can be made in a matter of seconds. Important advantages of the new product, other than the fact that the print may be inspected before proceeding with etching are: a shorter time of exposure, better detail, and elimination of the usual bichromate treatment which in the past has frequently caused soreness and irritation of the hands of workers who are sensitive to bichromate.

Cleveland Meeting

(Continued from page 70C)

ous parts of the U. S. as well as in the Pacific theater during his term of service in World War II, provides a fast moving entertainment combining magic, mind reading and hypnotism, with the emphasis on humor. There will be plenty of audience participation in what promises to be a sensational, truly hilarious good time. Following the program, a well-known orchestra will provide music for dancing.

No formal luncheons have been planned for Thursday or Friday. At this time, various Divisions are planning divisional luncheons for Wednesday and Friday.

Annual Business Meeting

The Annual Business Meeting of the Society, which in the past was held on Thursday morning preceding the first technical session, is scheduled as the featured event of the luncheon to be held on Thursday, April 20th.

It is hoped that all members attending the Convention will plan to attend this meeting, as its purpose is to give the individual member an opportunity to participate actively in the business affairs of the Society. Members are reminded that the Constitution states: "Business affecting the organization of the Society shall be transacted only at the annual meetings."

Cleveland Assures Interesting Program for Ladies

One of the most interesting and entertaining lecturers in the field of fashion and personality, Miss Elizabeth Kardos, Director of the Kardos Fashion Institute of Cleveland, will provide a program following the luncheon scheduled for Thursday noon. Ladies will tour the west side of Cleveland and its suburbs and will have their luncheon in the beautiful Seaglade room of the Lake Shore Hotel, overlooking Lake Erie.

In the platform presentation of "Packaging Your Personality," Miss Kardos will offer a visual demonstration which has delighted and instructed hundreds of women's groups throughout the midwest and Canada. The speaker has been recognized for many years as an authority in the field of creative and practical fashions and will demonstrate costumes for street wear, for afternoon, and for evening, with the choice of flattering accessories.

Using two contrasting figure types, as exemplified by herself and an assistant, Miss Kardos will discuss and analyze the various lines, styles, and colors in relation to figure problems. She will explain her own unusual approach to fashion, the underlying theme of which is the importance of the individual's personality and the correct interpretation of current fashions to portray that personality in the most pleasing manner.

The plans for the ladies' program on Friday will include an interesting tour, probably of the east side of Cleveland and the suburbs, and a complimentary luncheon at one of the local country clubs.

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